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VOLUME XX. DECEMBER, 1903.

PROCEEDINGS

OF THE

American Gas Light Association.

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THIRTY-FIRST ANNUAL MEETING

HELD AT

DETROIT, MICH., OCTOBER 21—23, 1903.

PUBLISHED BY THE ASSOCIATION.

EDITED BY THE SECRETARY.

CHARLES F. BLOOM
PRINTER AND BOOKBINDER
130–132 WILLIAM ST.
NEW YORK

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THE PROCEEDINGS

OF THE

American Gas Light Association.

THIRTY-FIRST ANNUAL MEETING,

HELD AT

THE MASONIC TEMPLE, DETROIT, MICHIGAN,

OCTOBER 21ST TO 23D, 1903.

FIRST DAY.—MORNING SESSION.

The Association was called to order at ten o'clock A. M. by the President, Mr. Alten S. Miller.

The following members were in attendance:

Active Members.

Africa, Walter G.,	Manchester, N. H.
Allen, Wm. H.,	Newark, N. J.
Ammon, Harry T.,	Wyandotte, Mich.
Arthur, F. M.,	Philadelphia, Pa.
Barret, A. H.,	Louisville, Ky.
Barrett, W. E.,	Ardmore, Pa.
Battin, H. S.,	Philadelphia, Pa.
Battin, Isaac,	Omaha, Neb.
Baxter, Isaac C.,	Detroit, Mich.
Beal, Thaddeus R.,	Poughkeepsie, N. Y.
Beck, George W.,	Sunbury, Pa.
Bennett, Chas. W.,	Red Bank, N. J.
Blinks, Walter M.,	Kalamazoo, Mich.
Blowers, Frank W.,	Kalamazoo, Mich.
Bredel, Frederick A.,	Milwaukee, Wis.
Brown, Ernest C.,	New York, N. Y.

Brown, Rezeau B.,	Milwaukee, Wis.
Buck, David, Jr.,	Coatesville, Pa.
Buck, H. M.,	Waukesha, Wis.
Butterworth, C. W.,	St. Albans, Vt.
Butterworth, Irvin,	Detroit, Mich.
Byers, C. A.,	Toledo, Ohio.
Cathels, Edmund,	Providence, R. I.
Clabaugh, G. W.,	Omaha, Neb.
Clark, Walton,	Philadelphia, Pa.
Cline, W. B.,	Los Angeles, Cal.
Coffin, Chas. Francis,	New York, N. Y.
Coggshall, H. F.,	Fitchburg, Mass.
Coles, J. M.,	Asbury Park, N. J.
Collins, David J.,	Philadelphia, Pa.
Cooper, Wm. H.,	Amsterdam, N. Y.
Cosgrove, W. L.,	Atlanta, Ga.
Cowdery, Ed. G.,	St. Louis, Mo.
Cressler, A. D.,	Fort Wayne, Ind.
Curtis, Sam'l Philip,	Philadelphia, Pa.
Daniels, John M.,	Columbia, S. C.
Dell, John,	St. Louis, Mo.
Dickey, Chas. H.,	Baltimore, Md.
Doherty, Henry L.,	New York, N. Y.
Donahue, E. J.,	Jersey City, N. J.
Douglas, Henry W.,	Ann Arbor, Mich.
Dunbar, Carl H.,	Elgin, Ill.
Dunbar, James W.,	New Albany, Ind.
Dutton, Lewis R.,	Wyncote, Pa.
Dutton, R. Hayes,	Hanover, Pa.
Earnshaw, Edward H.,	Philadelphia, Pa.
Evans, Chas. H.,	Chicago, Ill.
Eysenbach, Ernest E.,	St. Paul, Minn.
Faben, Chas. R., Jr.,	Toledo, Ohio.
Ferguson, B. B.,	Portsmouth, Va.
Fitz, Robert F.,	Boston, Mass.
Forbes, Charles,	London, Ont., Can.
Forbes, James,	Chattanooga, Tenn.
Forstall, Alfred E.,	New York, N. Y.
Frost, Wm. H.	Delray, Mich.

Geggie, David H., - - - - Quebec, Can.
Gerould, Charles L., - - - Galesburg, Ill.
Glass, Sheldon J., - - - - New York, N. Y.
Goodnow, George F., - - - Waukegan, Ill.
Graf, Carl H., - - - - - Detroit, Mich.
Gribbel, John, - - - - Philadelphia, Pa.
Guldlin, Olaf N., - - - - Fort Wayne, Ind.
Haase, Ewald, - - - - Milwaukee, Wis.
Haines, Jansen, - - - - Des Moines, Iowa.
Herron, J. T., - - - - Buffalo, N. Y.
Hilleke, August F., - - - - Ensley, Ala.
Horton, Thomas O., - - - Stapleton, N. Y.
Humphreys, Alex C., - - - New York, N. Y.
Humphreys, C. J. R., - - - New York, N. Y.
Humphreys, J. J., Jr., - - - Brooklyn, N. Y.
Hyde, Henry H., - - - - Racine, Wis.
Jones, T. C., - - - - - Delaware, Ohio.
Kellogg, L. L., - - - - Sioux City, Iowa.
Keppelman, John H., - - - Reading, Pa.
Klumpp, John B., - - - - Philadelphia, Pa.
Knapp, Isaac N., - - - - Ardmore, Pa.
Knight, J. J., - - - - Kalamazoo, Mich.
Lathrop, A. P., - - - - St. Paul, Minn.
Learned, Waldo A., - - - Newton, Mass.
Linton, S. E., Jr., - - - - Savannah, Ga.
Littlehales, Thomas, - - - Syracuse, N. Y.
Littlehales, Thos. G., - - - Chester, Pa.
Lynn, James T., - - - - Port Huron, Mich.
McCleary, Alex J., - - - - Philadelphia, Pa.
McDonald, Donald, - - - Louisville, Ky.
McDonald, William, - - - - Albany, N. Y.
McGregor, William, - - - Pawtucket, R. I.
McIlhenny, John, - - - - Philadelphia, Pa.
McIlhenny, John D., - - - Philadelphia, Pa.
McKenzie, W. H., - - - - Sioux Falls, S. D.
McLean, George, - - - - Dubuque, Iowa.
Macmillan, Robert, - - - - Kansas City, Mo.
Mann, Howard E., - - - Cleveland, Ohio.
Mansur, John H., - - - - Royersford, Pa.

Max, Wm. J., - - - - - Middletown, N. Y.
Mayers, J. Alex., - - - - New York, N. Y.
Merrifield, L. L., - - - - Toronto, Can.
Merritt, Albert H., - - - Niagara Falls, N. Y.
Miller, Alten S., - - - - Baltimore, Md.
Mitchell, Kerr M., - - - St. Joseph, Mo.
Morgans, William H., - - - Pontiac, Mich.
Morris, W. Cullen, - - - Long Isl'd City, N.Y.
Morrison, H. K., - - - - Concord, N. H.
Moses, Frank D., - - - - Trenton, N. J.
Nettleton, Chas. H., - - - Derby, Conn.
Norcross, J. Arnold, - - - New Haven, Conn.
Norris, Rollin, - - - - - Philadelphia, Pa.
Nute, Joseph E., - - - - Fall River, Mass.
Parker, Frank H., - - - - Burlington, Vt.
Polk, Roger W., - - - - Rutland, Vt.
Powers, Edgar T., - - - - Baltimore, Md.
Pratt, Edward G., - - - Milwaukee, Wis.
Prichard, Charles F., - - - Lynn, Mass.
Purcell, T. V., - - - - Chicago, Ill.
Quinn, Andrew K., - - - - Newport, R. I.
Ramsdell, George G., - - - New York, N. Y.
Reitemeyer, A. F., - - - - Elizabeth, N. J.
Rice, Henry L., - - - - Norfolk, Va.
Riselay, Wm. S., - - - - Buffalo, N. Y.
Roohan, P. F., - - - - Saratoga Spr., N. Y.
Roper, George D., - - - - Rockford, Ill.
Russell, Daniel R., - - - St. Louis, Mo.
Sawyer, F. H., - - - - Norfolk, Va.
Searle, R. M., - - - - Mount Vernon, N. Y.
Serrill, William J., - - - - Philadelphia, Pa.
Shattuck, John D., - - - Chester, Pa.
Shelton, F. H., - - - - Philadelphia, Pa.
Smart, Fred. R., Jr., - - - York, Pa.
Smith, William H., - - - - Philadelphia, Pa.
Somerville, James, - - - - Indianapolis, Ind.
Spangenberg, B. H., - - - Philadelphia, Pa.
Spinning, W. V., - - - - Peru, Ind.
Stacey, James E., - - - - Cincinnati, Ohio.

Stratton, F. A.,	Mount Vernon, N. Y.
Tait, Frank M.,	New London, Conn.
Thompson, F. de V.,	Springfield, Mass.
Tippy, B. O.,	Detroit, Mich.
Tobey, Franklin, Jr.,	Kingston, N. Y.
Wainright, A. V.,	So. Norwalk, Conn.
Wales, Harry B.,	Grand Rapids, Mich.
Walters, Benj. S.,	Blue Island, Ill.
Warmington, Daniel R.,	Cleveland, Ohio.
Wells, L. W.,	Canton, Ohio.
Whipple, Henry S.,	Rockford, Ill.
White, William Henry,	New York, N. Y.
Williams, L. S.,	Harrisburg, Pa.
Woodward, Ralph,	Pittsfield, Mass.
Wortendyke, Ira F.,	Janesville, Wis.
Young, Alfred W.,	Knoxville, Tenn.
Young, John,	Allegheny, Pa.
Young, J. M. H.,	Joplin, Mo.
Young, Robert,	Pittsburg, Pa.

Associate Members.

Alcott, Franklyn L.,	Cleveland, Ohio.
Barbour, W. T.,	Detroit, Mich.
Bunnell, Sterling H.,	Lorain, Ohio.
Carpenter, H. A.,	Pittsburg, Pa.
Cartwright, Henry R.,	Philadelphia, Pa.
Crane, William M.,	New York, N. Y.
Cressler, Alfred M.,	Fort Wayne, Ind.
Cressler, George H.,	Fort Wayne, Ind.
De Hart, J. S., Jr.,	Newark, N. J.
Eaton, Alfred B.,	Chicago, Ill.
Fiske, John T.,	Port Chester, N. Y.
Graves, George W.,	Rochester, N. Y.
Harper, H. D.,	Chicago, Ill.
Jacobs, Chas. H.,	Detroit, Mich.
Kenah, R. L., Jr.,	New Brighton, Pa.
Leakey, Nathan G.,	Detroit, Mich.
McDonald, Donald,	Albany, N. Y.

Mills, William A.,	Port Chester, N. Y.
Mueller, Robert,	Decatur, Ill.
Nichols, Carroll B.,	Philadelphia, Pa.
Norton, Harry A.,	Boston, Mass.
Osius, George,	Detroit, Mich.
Persons, F. R.,	Toledo, Ohio.
Plantinga, Pierre,	Cleveland, Ohio.
Prendergast, Daniel J.,	New York, N. Y.
Rodgers, E. H.,	Philadelphia, Pa.
Steinwedell, W. E.,	Cleveland, Ohio.
Stratton, S. S.,	Chicago, Ill.
Terhune, Chas. F.,	New York, N. Y.
Van Wie, E. G.,	Detroit, Mich.
Welch, John S.,	Philadelphia, Pa.
Wells, Fred. K.,	New York, N. Y.
Wharton, Henry,	Philadelphia, Pa.
Wickham, Leigh,	St. Louis, Mo.

THE PRESIDENT: — Gentlemen, please come to order. Gentlemen of the American Gas Light Association: I wish to introduce to you the Hon. William C. Maybury, Mayor of Detroit, who will be kind enough to welcome us on this occasion.

MAYOR MAYBURY welcomed the Association to Detroit in a felicitous speech, which was fittingly responded to on behalf of the Association by Mr. Edward G. Cowdery.

THE PRESIDENT:—The next order of business is the reading of the minutes of the last meeting.

MR. EDWARD G. PRATT (Milwaukee, Wis.):—Inasmuch as the minutes of the last meeting have been published, I move that the reading of the minutes at this time be dispensed with.

Carried.

THE PRESIDENT:—The next business is the report of the Council upon the Applications for and Transfers of Membership.

The Secretary read the following report:

DETROIT, October 21, 1903.

To the American Gas Light Association,

GENTLEMEN:—Your Council have approved the following applications for membership and submit them to you with the recommendation that they receive favorable action.

Proposed for Active Membership.

Allyn, G. E., 15 Beacon Ave., Providence, R. I., Superintendent of Distribution of the Providence Gas Co.

Bailey, W. Frank, Wilmington, Del., Superintendent of Distribution of the Wilmington Gas and Electric Co.

*Baldwin, Wareham S., Detroit, Mich., Superintendent of Station B, Detroit City Gas Co.

Ball, James, Philadelphia, Pa., Assistant Treasurer of the United Gas Improvement Co.

Barclay, V. B., Newport News, Va., Superintendent of the Newport News Gas Co.

*Bertrand, P. A., Springfield, Mo., General Manager of the Springfield Gas and Electric Co.

Bradley, Savery, Atlantic City, N. J., President of the Atlantic City Gas and Water Co.

Brainard, Don C., Carthage, Mo., General Manager of the Carthage Light, Heat and Power Co.

Braine, John H., 37 Lombardy St., Newark, N. J., Superintendent of Distribution, Newark District, Public Service Corporation of New Jersey.

*Bryant, Charles F., Bridgeport, Conn., Auditor of the Connecticut Railway and Lighting Co.

Bunker, Theodore, 418 Federal St., Camden, N. J., Superintendent of Distribution South Jersey Division, Public Service Corporation of New Jersey.

Butler, Matthew W., 2108 N. 20th St., Philadelphia, Pa., Engineer of the Pennsylvania Gas Improvement Co.

* Present at Meeting.

Byrne, Edward J., Fifth and Hoyt Sts., Brooklyn, N. Y., Superintendent of the Brooklyn Union Gas Co.

Clark, John C. D., 716 Locust St., St. Louis, Mo., Superintendent of New Business Department of the Laclede Gas Light Co.

*Coate, P. S., Chatham, Ontario, Canada, Manager and Secretary-Treasurer of the Chatham Gas Co., Limited.

*Combs, Roger B., Broad and Arch Sts., Philadelphia, Pa., Engineer with the United Gas Improvement Co.

Copley, I. C., Aurora, Ill., President, Treasurer and Manager of the La Grange Gas Co., Joliet Gas Light Co. and Fox River Light, Heat and Power Co.

Cresson, B. F., Easton, Pa., Secretary of the Easton Gas and Electric Co.

*Crowell, Frederick B., 38 Thurman St., Atlanta, Ga., Superintendent of the Atlanta Gas Light Co.

Curtis, George W., Camden, N. J., Superintendent of Manufacturing, South Jersey Division, Public Service Corporation of New Jersey.

Davidson, Rolland A., Newburgh, N. Y., General Manager of the Newburgh Light, Heat and Power Co.

Davies, George, 155 Railroad Ave., White Plains, N. Y., Superintendent of White Plains District, Westchester Lighting Co.

Doig, George I., Gainesville, Fla., Superintendent and General Manager of the Gainesville Gas and Electric Light Co.

Dougherty, Dan J., Jacksonville, Fla., Superintendent of the Citizens' Gas Co.

*Ellis, John W., Woonsocket, R. I., President and Manager of the Providence Gas Co.

*Engel, Francis, Elizabeth, N. J., Superintendent of the Elizabethtown Gas Light Co.

Ferris, Herbert H., 13th and Clinton Sts., Hoboken, N. J., Superintendent of Hoboken Works, Public Service Corporation of New Jersey.

* Present at Meeting.

Flick, Warren J., 74 South Main St., Bethlehem, Pa., General Manager of the Wyandotte Gas Co.

Fox, Clifford S., Long Island City, N. Y., Superintendent of Distribution of The East River Gas Co.

Geist, C. H., 619 N. Y. Life Bld'g., Chicago, Ill., President Hammond Illuminating Co.

Gilkyson, J. R., 418 Federal St., Camden, N. J., General Agent of the Public Service Corporation of New Jersey.

* Gould, Vernon K., 18 Central St., Bangor, Maine, Superintendent of the Bangor Gas Light Co.

* Grover, T. F., Fond du Lac, Wis., Vice-President and General Manager of the Eastern Wisconsin Railway and Light Co.

Healy, William M., Fort Dodge, Iowa, General Manager of the Fort Dodge Light and Power Co.

Hill, Samuel, 214 Cherry St., Seattle, Wash., President of the Seattle Gas and Electric Co.

* Hurlburt, A., Broad and Arch Sts., Philadelphia, Pa., Engineer with the United Gas Improvement Co.

* Irwin, C. Henry, 196 Union Ave., Long Branch, N. J., Treasurer of the Consolidated Gas Co., of New Jersey.

* Jelliffe, C. N., 40 Wall St., New York City, Auditor of the American Light and Traction Co.

* Kidner, R. W., London, Ont., Canada, Secretary of the City Gas Company of London, Ont.

Leland, George B., Norwich, Conn., Superintendent of the Norwich Gas and Electric Co.

Maloney, Andrew P., 1504 Tioga St., Philadelphia, Pa., Secretary and Treasurer of the Lakewood Gas Co.

Marple, William M., 423 Jefferson Ave., Scranton, Pa., Engineer Scranton Gas and Water Co.

* Merritt, William H., Lebanon, Pa., Superintendent of the Lebanon Gas Co.

* Miller, Thomas David, Baronne and Common Sts., New Orleans, La., Manager of the New Orleans Lighting Co.

* Present at Meeting.

Miller, William B., Augusta, Ga., Superintendent of the Gas Light Co. of Augusta.

* Moore, A. W., Woodstock, Ontario, Canada, Secretary of the Woodstock Gas Light Co.

Norland, Manning A., 157 Michigan Ave., Chicago, Ill., Assistant Engineer of the People's Gas Light and Coke Co.

Oill, George L., St. Thomas, Ontario, Canada, Manager of the St. Thomas Gas Co.

* Palmer, L. T., Tonawanda, N. Y., Secretary and General Manager of the Niagara Light, Heat and Power Co.

Patterson, H. V., 6th and Provost Sts., Jersey City, N. J., Superintendent of Mains and Services, Jersey City District, Hudson County Division, Public Service Corporation of New Jersey.

* Pease, A. C., 119 Woodworth Ave., Yonkers, N. Y., Superintendent of Yonkers District, Westchester Lighting Co.

* Powell, H. H., Woodstock, Ontario, Canada, President of the Woodstock Gas Light Co.

Putnam, W. R., Red Wing, Minn., Secretary and Manager of the Red Wing Gas and Electric Co.

Royce, F. P., 159 Devonshire St., Boston, Mass., Vice-President of the Springfield (Mass.) Gas Light Co., and Suburban Gas and Electric Co., Revere.

Schenck, Rudolph, 157 Michigan Ave., Chicago, Ill., Assistant Engineer of the People's Gas Light and Coke Co.

Scott, Charles L., Commonwealth Building, Philadelphia, Pa., Secretary of the Pennsylvania Gas Improvement Co.

Scranton, George H., Derby, Conn., Secretary of the Derby Gas Co.

Shepherd, Herbert L., Dover, N. H., Treasurer and General Manager of the United Gas and Electric Co.

Simpson, Colin C., 4 Irving Place, New York City, Assistant Secretary and General Superintendent of Mains, Consolidated Gas Co., of New York.

* Present at Meeting.

Stephenson, William, South Amboy, N. J., Agent for the Citizens' Light and Fuel Co.

Tenney, Charles H., 159 Devonshire St., Boston, Mass., President of the Springfield (Mass.) Gas Light Co., and Suburban Gas and Electric Co., Revere.

* Tompkins, John P., Atlantic City, N. J., Secretary and General Manager of the Atlantic City Gas and Water Co.

von Maur, Jacob D., 4469 Berlin Ave., St. Louis, Mo., Superintendent of Street Department, Laclede Gas Light Co.

* Walker, William L., Fitchburg, Mass., Superintendent of Gas Department, Fitchburg Gas and Electric Light Co.

* Wallace, Robert A., 151 Park St. N., Hamilton, Ontario, Canada, Superintendent of Hamilton Gas Light Co.

Weaver, R. S., Port Jervis, N. Y., General Manager of the Port Jervis Electric Light, Power, Gas and Railroad Co.

Whitaker, J. S., Portsmouth, N. H., Superintendent of the Rockingham County Light and Power Co.

White, Edwin C., Long Branch, N. J., Superintendent of the Consolidated Gas Co., of New Jersey.

Whitson, John G., Watsonville, Cal., President of the Watsonville Gas Co.

* Wilson, W. A., Portage, Wis., Superintendent of the Portage American Gas Co.

* Wolff, Samuel E., 260 Main St. E., Jackson, Mich., Secretary and General Manager of the Jackson Gas Co.

Proposed for Associate Membership.

Brownell, E. E., Dayton, Ohio, Electrical Engineer.

* Case, C. A., Auburn Park, Chicago, Ill., General Solicitor for the Elgin American Gas Co.

* Cheesman, Frank P., 92 William St., New York City, Partner, National Paint Works.

* Collins, Warren, Stamford, Conn., Representative of the Stamford Gas Stove Co.

* Present at Meeting.

* Cox, Edward L., 371 Fifth Ave., New York City, Traveling Salesman for the Oxley & Enos Manufacturing Co.

* Cruse, Arthur R., 1205-06 Stephen Girard Building, Philadelphia, Pa., President of the Cruse-Kemper Co.

* Garrison, John J., 26 Cumberland St., Boston, Mass., Special Representative for Gas Department of Detroit Stove Works.

Granger, W. R., Montreal, Canada, General Manager of the Auer Incandescent Light Manufacturing Co., Limited.

* Kellum,, Benjamin J., 68 and 70 Wabash Ave., Chicago, Ill., Manager of the Welsbach Co.

* Lindsay, Charles R., 170 Lake St., Chicago, Ill., Lindsay & Co.

* McNary, J. B., Windsor, Ontario, Canada, Manager of the Canadian Meter Co.

* Mason, Sidney, Philadelphia, Pa., President of the Welsbach Light Co., U. G. I. Building.

Nicol, John F., Otto, Pa., Assistant to President of the American Coke and Gas Construction Co.

* Parker, George W., 45 Broadway, New York City, Eastern Agent for the Parker-Russell Mining and Manufacturing Co.

Pattison, Melvin, Cleveland, Ohio, Representative of the Brown Hoisting Machinery Co.

* Rancke, Louis N., Hull and Nicholson Sts., Locust Point, Baltimore, Md., Superintendent of the Baltimore Retort and Fire Brick Co.

* Schumacher, Gerard, 116 Nassau St., New York City, Second Vice-President of the Central Foundry Co.

Warren, Henry J., Stamford, Conn., President of the Stamford Gas Stove Co.

Wilkin, John T., Connersville, Ind., Mechanical Engineer of the Connersville Blower Co.

Zwisler, A. L., Kalamazoo, Mich., Salesman for the General Gas Light Co.

* Present at Meeting.

Proposed for Junior Membership.

Allison, Walter A., 2142 Sedgley Ave., Philadelphia, Pa., Foreman of Mains and Services, Philadelphia Gas Works, Spring Garden District.

Bucher, Paul, 155 Railroad Ave., White Plains, N. Y., Assistant to the Superintendent of the Westchester Lighting Co.

* Burnett, Frederick, 269 Front St. East, Toronto, Canada, Assistant to L. L. Merrifield, Economical Gas Apparatus Construction Co.

Butler, J. F., Ardmore, Pa., Cadet Engineer, Merion and Radnor Gas and Electric Co.

Cadwallader, Lacey L., 408 Lyceum Ave., Roxborough, Philadelphia, Pa., Foreman of Mains and Services, Philadelphia Gas Works.

* Calkins, W. B., St. Louis, Mo., Chief Chemist of the Laclede Gas Light Co.

Castor, William A., 1646 Dyre St., Frankford, Pa., Assistant Superintendent City District, Philadelphia Gas Works.

Christy, Henry B., 1308 Arrott St., Frankford, Philadelphia, Pa., Assistant Foreman of Mains and Services, Philadelphia Gas Works.

Dunne, Philip, 1931 South 9th St., Philadelphia, Pa., Foreman of Fitters, Philadelphia Gas Works.

Fitzpatrick, Dan, St. Augustine, Fla., Machinist and Foreman of Works, St. Augustine Gas and Electric Light Co.

Forbes, Walter, Chattanooga, Tenn., Foreman Chattanooga Gas Light Co.

Fowler, Joseph W., 16 East Forsythe St., Jacksonville, Fla., Assistant Superintendent of the Citizens' Gas Co.

Frick, John Arthur, Philadelphia, Pa., Street Clerk, Philadelphia Gas Works.

Fulweiler, Walter Herbert, 1st and Combell Sts., Kansas City, Mo., Cadet Engineer with the Kansas City Missouri Gas Co.

* Present at Meeting.

Gillingham, Hubert D., 4529 Pulaski Ave., Germantown, Philadelphia, Pa., Foreman of Mains and Services, Germantown District, Philadelphia Gas Works.

Graham, L. C., 5715 Ashland Ave., Philadelphia, Pa., Foreman of Mains and Services, West Philadelphia District, Philadelphia Gas Works.

Green, Albert, 4518 Tacony St., Frankford, Philadelphia, Pa., Foreman of Fitters of the Philadelphia Gas Works.

Hammond, Eric W., Llanwellyn P. O., Delaware County, Pa., Street Clerk, Philadelphia Gas Works.

Johnston, Ernest, St. Augustine, Fla., Chief Clerk, St. Augustine Gas and Electric Light Co.

Kellogg, R. M., 119 Woodworth Avenue, Yonkers, N. Y., Cadet Engineer with the Westchester Lighting Co.

Keppleman, D. Ellwood, 3729 North Carlisle St., Philadelphia, Pa., Foreman of Fitters, Spring Garden District, Philadelphia Gas Works.

Laubenstein, A. R., 1946 North 23d St., Philadelphia, Pa., Assistant to Superintendent of Meters, Philadelphia Gas Works.

Lucena, Joseph, 3650 Market St., Philadelphia, Pa., Foreman of Fitters, West Philadelphia District, Philadelphia Gas Works.

Macbeth, G. T., 119 Woodworth Ave., Yonkers, N. Y., Works Foreman, Westchester Lighting Co.

Morgan, J. E., Mount Vernon, N. Y., Cadet Engineer with the Westchester Lighting Co.

Myler, J. A., Jr., P. O. Box No. 39, Mamaroneck, N. Y., Foreman of Special Mains, Westchester Lighting Co.

Parker, John C., 127 Seymour St., Germantown, Philadelphia, Pa., Assistant Service Foreman, Germantown District, Philadelphia Gas Works.

Parker, Joseph Smith, 2003 South Cleveland Ave., Philadelphia, Pa., Foreman of Mains, Philadelphia Gas Works.

Price, William H., Lakewood, Kent County, R. I., Clerk with the Providence Gas Co.

Roberts, F. M., Main and Adee Sts., Portchester, N. Y., Assistant to the Superintendent of the Westchester Lighting Co.

Schauer, Frank F., 2157 North Van Pelt St., Philadelphia, Pa., Foreman of Mains, Frankford District, Philadelphia Gas Works.

* Skinner, Samuel, 177 Harbor St., Montreal, Canada, Superintendent of Gas Department of the Montreal Light, Heat and Power Co.

Terry, H. W., Jr., 215 South Third Ave., Mount Vernon, N. Y., Chemist and Cadet Engineer with the Westchester Lighting Co.

Tinsman, E. H., 122 West Sharpnack St., Germantown, Philadelphia, Pa., Chief Clerk, City District, Philadelphia Gas Works.

Umstead, Elmer S., 1934 North Gratz St., Philadelphia, Pa., Foreman of Services, Philadelphia Gas Works.

Williams, Thomas G., 1931 South Ninth St., Philadelphia, Pa., Foreman of Street Leaks, Philadelphia Gas Works.

Transfer from Associate to Active Membership.

Summey, D. L., Center and Leavenworth Sts., Waterbury, Conn., Assistant Superintendent of the United Gas Improvement Co.

Vincent, G. I., 4705 Chester Ave., Philadelphia, Pa., Assistant Superintendent, Spring Garden District, Philadelphia Gas Works.

Walter, E. P., 6554 Germantown Ave., Germantown, Pa., Superintendent Germantown District, Philadelphia Gas Works.

* Present at Meeting.

Number of Applications—Active . .	71
" " Associate . .	20
" " Junior . . .	36
Total	127
Transfers	3

Respectfully submitted for the Council,

ALFRED E. FORSTALL, *Secretary.* ALTEN S. MILLER, *President.*

THE PRESIDENT :—Gentlemen, you have heard the recommendations of the Council. What is your pleasure?

MR. WALTON CLARK (Philadelphia, Pa.):—Do I understand that Mr. Mason was recorded as an applicant for the position of associate member?

THE SECRETARY :—His application for active membership was not accepted.

MR. WALTON CLARK :—I want to say that I indorsed an application for active membership, and do not know whether Mr. Mason desires to be elected to associate membership. Unless there is some other information at hand, I shall withdraw his application. I do not want him to be elected, on my indorsement, to a class of membership for which he did not apply.

THE PRESIDENT :—Going by an old custom, he is recommended for election as an associate member, with the privilege of accepting or not—he can qualify as an associate member or not. If you prefer to withdraw his name you can do it, and Mr. Mason's application need not be voted on.

MR. WALTON CLARK :—It is all right if it is left to him to accept or not as he pleases. I do not know what his idea may be concerning the matter.

THE SECRETARY :—I will state for the benefit of Mr. Clark that in notifying Mr. Mason of his election, I will explain to him that he is elected as an associate member without consulting him, because we had no time to consult him or any of his indorsers, and that he is at perfect liberty not to accept the election if he does not care to do so. The election does not

bind him in any way, shape or form. We thought he might like to be an associate member and we decided to give him the opportunity of becoming such.

MR. THOMAS O. HORTON (Stapleton, N.Y.) :—I move that the Secretary be instructed to cast the ballot of the Association for the applicants whose names have been reported favorably by the Council.

THE PRESIDENT :—If there is no objection to that, I will appoint as tellers Messrs. Irvin Butterworth and K. M. Mitchell.

THE SECRETARY :—Hearing no objection, I cast the ballot of the Association, as directed by the motion of Mr. Horton.

MR. IRVIN BUTTERWORTH (Detroit, Mich.):—Mr. President, we find that the gentlemen whose names have been read at the meeting have been duly elected members of the Association.

THE PRESIDENT :—Gentlemen, you have heard the report of the tellers that the applicants have been elected, and they are hereby declared to be so elected. Will the new members who are present please rise? (Newly elected members rise.) Gentlemen, you are all expected to take part in the proceedings. You are full members from this time, and are not expected to wait for any further qualification. We hope you will take part in the proceedings and discuss all questions freely. We are very glad to welcome you as members of the Association.

The next order of business is the report of the Council.

The Secretary read the following :

REPORT OF COUNCIL.

DETROIT, Mich., Oct. 21, 1903.

The American Gas Light Association,

GENTLEMEN :—Your Council has the honor to make its annual report as follows :

A separate report upon applications for membership recommends the election of 127 applicants.

The resignations of six active members and one associate member have been received and accepted during the year.

The following list of papers has been approved to be read at this meeting:

"Our Correspondence School," by Alex. C. Humphreys, New York City.

"The Policy of Gas Enrichment (illustrated by London practice)," by Arthur G. Glasgow, London, England.

"Some Features of Municipal Ownership," by Henry L. Doherty, New York City.

"Notes on the Operation of Large Carburetted Water-Gas Sets," by W. Cullen Morris, Long Island City, New York.

The Council has been successful in making arrangements for a lecture on the subject of "Gas Engines," to be delivered before the Association on the morning of Thursday, October 22d, by Alfred H. White, of the University of Michigan.

The Council recommends that the subscription of the Association to the Educational Fund be renewed for a further period of five years, for the same annual amount, $250.

The movement toward a Gas Exhibit at the Louisiana Purchase Exposition, having been brought to the attention of the Council, it recommends to the members of the Association that they give it their hearty co-operation, and that they contribute, each to the extent of his ability, to the success of the Exhibit.

During the year the report of the Committee on a Uniform System of Accounts for Gas Companies, as presented and accepted at the last meeting, has been published and issued to all the members of the Association. The Council has voted that extra copies of this report may be purchased by members of the Association at a price of five dollars per copy, and copies will be sold to non-members of the Association at a price of ten dollars per copy. It has also voted that as long as the supply lasts each new member elected will have the privilege of purchasing a single copy at the price of two dollars; any extra copies desired to be had at the regular price of five dollars per copy.

Respectfully submitted,

ALTEN S. MILLER, *President.*

ALFRED E. FORSTALL, *Secretary.*

THE PRESIDENT :—What action do you take upon the report of the Council?

MR. ROLLIN NORRIS (Philadelphia, Pa.):—I move that the report be accepted and the recommendations adopted.

Carried.

THE PRESIDENT :—I understand that Mr. Fred. H. Shelton, of Philadelphia, desires the floor for a brief time to present a matter to the Association.

MR. F. H. SHELTON (Philadelphia, Pa.):—I have asked the privilege of the floor in connection with a matter referred to in the report of the Council—the exhibit of the Western Gas Association in St. Louis next year at the time of the Exposition. It seems to me that this is a subject that ought to be well within the knowledge of all the Associations, and ought to be heartily pushed along by each Association and by each member to the fullest extent of our respective abilities. We know that as yet, for one reason or another, no gas exhibit worthy of the name has ever been held at any American Exposition. It does seem, however, that this coming year, in 1904, there will be an opportunity for a most creditable exhibit of gas appliances, gas apparatus and early gas forms of great interest, of great benefit to our business and of great credit to our profession.

The Western Gas Association has taken the initiative in this movement chiefly because of its location in the Mississippi Valley, and also because of there being, as yet, no step taken by any other association toward an exhibit. The opportunity appears to exist and the worthiness of the object, I think, is admitted. The Western Association has delegated to me more or less power to act in the matter, and, after conference with the management of the World's Fair, I am very glad to be able to report to gas men at large that arrangements have virtually been made for a comfortable amount of space, excellently located, details are fairly worked out, and a large amount of co-operation is assured from various gas companies, supply houses and individuals who will all contribute to the total result.

It is a little difficult to say exactly what your Association, as an association, can do, because we are not, for instance (in

here representing the Western Association) asking for subscriptions to that end. The funds will be taken care of without action by the associations through individual subscription channels, in all likelihood. The amount involved is fairly reasonable, and there appears to be no financial difficulty; but the success of such an exhibit will depend necessarily upon the completeness and fullness of the material we get together; and I do want to appeal to the American Association, as a body, and to the members as individuals to help push along to a successful conclusion this first gas exhibit that we think will be worthy of the name, that will have been made by the American gas profession.

The purpose is to have three separate classes of exhibits; first, samples and models of apparatus representative of *the state of the art to-day;* that is, gas house machinery, condensers, scrubbers, meters, purifiers, water-gas apparatus and coal-gas apparatus, all to be shown by samples or models to be assembled as typical of present producing apparatus. Distribution methods, mains, meters, service pipes and other appliances that are used in distribution will follow. Samples (secondly) will be shown of burners, the incandescent series especially, high-candle power lamps, and the other appliances for *utilizing* our product. I think these will all appear in a finer collection than we have ever yet seen. We are expecting to get the best group and collection of *gas-consuming appliances* ever assembled in this country, which should be both of great interest to the public and educative and helpful to visiting gas men. In addition to the current practice that will be shown, it is hoped to have (thirdly) a very strong showing of early or *historical forms* of machinery, of old parts and appliances that are available from different works and different manufacturers, which, put together as a whole, will make an interesting historical exhibit, and with the exhibit of current apparatus and the appliances for the use of gas will complete the three kinds of exhibits which it is aimed to put together. I sincerely hope that each member of this Association will co-operate with "the Western" in building up this exhibit by lending what each member can, or suggesting what a neighbor may be able to lend to the exhibit.

The exhibit is not intended to be limited to any particular section. It is not a matter of the Western Association, or of any other association, except that the Western Association has first taken the matter up to start it along. It will be glad of the co-operation of every other association and individual, and it simply desires to start and help in the best efforts to make an exhibit that will be creditable to the industry, representative of the entire industry, and not to be bounded by any section or association. I hope each member here will do something to help the exhibit to a successful conclusion.

THE PRESIDENT :—The next order of business is the report of the Secretary and Treasurer.

REPORT OF TREASURER FOR YEAR ENDING SEPT. 30, 1903.

Receipts.

Dues for year 1900	$15.00	
" " 1901	45.00	
" " 1902	135.00	
" " 1903	3,040.25	
" " 1904	35.25	
		$3,270.50
Initiation Fees, Members elected October 15, 1902		1,180.60
Sale of Proceedings		291.70
Sale of Association Badges		10.50
Sale of Report on Uniform Accounts		56.75
Interest on Deposit in Savings Bank		48.45
Total Receipts		$4,857.90
Cash balance from last year,		
Permanent Fund	$200.47	
Current Fund	598.21	798.68
Total		$5,656.58

Total Receipts brought forward, - - -		$5,656.58

Expenditures.

Expense of 30th Annual Meeting -	$101.10	
Report of 30th Annual Meeting - -	100.00	
Expense of May Council Meeting -	33.24	
Report of May Council Meeting - -	20.00	
Publishing Proceedings, Vol. XIX -	1,285.55	
Distribution of Proceedings, Vol. XIX -	139.25	
Printing Advance Copies of Papers -	69.00	
Publishing Report of Committee on Uniform Accounts - - -	1,674.39	
Distribution of Report of Committee on Uniform Accounts - - -	141.40	
Subscription to Educational Fund - -	250.00	
Salary of Secretary and Treasurer -	600.00	
Subscriptions to Publications - -	9.38	
Binding Books - - - -	181.00	
Miscellaneous Printing, Circulars, Programmes, etc. - - - -	137.75	
Postage Stamps and Stamped Envelopes	33.27	
Membership Badges - - -	402.15	
Stationery - - - - -	19.18	
Telephone and Telegrams - -	7.12	
Expressage - - - -	21.82	
Book Cases - - - -	37.75	
Railroad Agent - - - -	12.00	
Office Expenses - - -	8.29	
Total - - - - -		$5,283.64

Balance—Permanent Fund	$200.47	
Current Fund	172.47	
		372.94
Net Balance in National Newark Banking Company - -	$137.28	
Cash in Savings Bank -	235.66	$372.94

DETROIT, Mich., Oct. 20, 1903.

We, the undersigned members of the Finance Committee of the American Gas Light Association, have this day examined the books and accounts of Alfred E. Forstall, Secretary and Treasurer, for the year ending September 30, 1903, and have found the same to be correct.

ROLLIN NORRIS, *Chairman*,
E. G. COWDERY,
CHAS. F. PRICHARD,
Finance Committee.

THE SECRETARY:—This report shows an excess of expenses over income of $428. This was caused by the printing and distribution of the report of the Committee on Uniform Accounts, the expense of which amounted to some $1,800. If our expenditures had been normal we would have come out with the expenses about $1,400 less than the income.

MEMBERSHIP REPORT OF SECRETARY FOR YEAR ENDING SEPT. 30, 1903.

Honorary Members.

On Roll October 1, 1902		11	
Elected October 15, 1902		1	
On Roll September 30, 1903			12

Active Members.

On Roll October 1, 1902		483	
Elected October 15, 1902		101	
			584
Dropped from Roll October 14th		10	
Transferred from Active to Honorary, October 15, 1902		1	
Did not qualify		2	
Deceased		5	
Resigned		6	
			24
On Roll September 30, 1903			560

Brought forward		572

Associate Members.

On Roll October 1, 1902	92	
Elected October 15, 1902	19	
	111	
Deceased	1	
Resigned	1	
	2	
On Roll September 30, 1903		109
		681

DECEASED.

Active.

Elmer B. Knight, Far Rockaway, N. Y., June 17, 1902.
Frederick A. Welles, Jersey City, N. J., December 16, 1902.
William K. Park, Philadelphia, Pa., May 13, 1903.
Eugene Vanderpool, Newark, N. J., July 12, 1903.
Henry B. Leach, Taunton, Mass., July 25, 1903.

Associate.

Julius Buss, Milwaukee, Wis., November 23, 1902.

RESIGNED.

Active.

George S. Capelle	Wilmington, Del.
John H. Poole	Denver, Col.
Charles H. Raynor	Adrian, Mich.
R. A. C. Smith	New York City.
Wm. C. Thomas	Hackensack, N. J.
J. B. T. Tuthill	Salem, Oregon.

Associate.

J. O. Nicolls	Philadelphia, Pa.

DROPPED BY ACTION OF COUNCIL.

Active.

M. Bowes	Raleigh, N. C.
J. H. Cardall	Memphis, Tenn.
John Clements	Salinas, Cal.
J. H. Findlay	Ogdensburg, N. Y.
L. C. Hanford	Norwalk, Conn.
John T. Langford	Boston, Mass.
John Lloyd	Altoona, Pa.
Ferdinand McKeige	Address Unknown.
Wm. MacDonald	Philadelphia, Pa.
Wm. H. Ward	Easton, Pa.

THE PRESIDENT :—Gentlemen, you have heard the reports. What action do you take upon them?

MR. E. G. PRATT (Milwaukee, Wis.):—I move that the reports be received and spread on the records.

Carried.

THE PRESIDENT :—The next order of business is the report of special committees, and we will hear from the Trustees of the Educational Fund.

THE SECRETARY :—This report has, as a matter of custom, been taken up under the order of reports of special committees, although the Board of Trustees Gas Educational Fund is not really a special committee of the Association, being an entirely separate and distinct body which was organized by the Association on a self-continuing basis.

FIFTH ANNUAL REPORT OF THE TRUSTEES GAS EDUCATIONAL FUND, TO THE AMERICAN GAS LIGHT ASSOCIATION AND OTHER SUBSCRIBERS.

To the American Gas Light Association and Subscribers:

GENTLEMEN :—The Trustees appointed at the Twenty-sixth Annual Meeting of the Association, held October 17th, 1898, to administer the Educational Fund formed by your subscriptions, submit the following report as to the work done from October 1st, 1902, to September 30th, 1903.

We are compelled to record with great sorrow our first loss by death, that of Eugene Vanderpool.

One of the original Permanent Trustees, Mr. Vanderpool was elected Treasurer when the Board organized and remained in that position until his death July 12th, 1903. Having received a technical education, a rare thing among the men who entered the gas business in the late sixties and early seventies, he appreciated fully the advantages to be derived by the gas industry from the work of the Board and was earnest in attention to his duties as a member and an officer. His large experience and sound judgment in engineering and financial matters rendered his counsel valuable and made his loss a severe one. Not content with doing what he could while living, he had given instructions that after his death his valuable gas library should be given to the Board and this has since been done. This bequest still further increases the debt owed him by everyone interested in our work. At a meeting held July 22d, the following minute was adopted :

"Eugene Vanderpool, member and treasurer of this Board from its foundation, died July 12th, 1903. By Mr. Vanderpool's death this Board loses an interested, efficient and conscientious officer and member. To the knowledge that his judgment, founded on inherent good sense and tempered by experience in positions of responsibility in engineering and financial institutions, was influencing the actions of this Board, has been due, in large measure, the confidence of the gas profession in our undertaking.

"This Board will miss the wise counsel of its late member, and the Trustees mourn the loss of a man whose personal qualities made association with him a privilege and a pleasure.

"The Trustees, desiring to place on record their appreciation of his services, their feeling of personal sorrow and loss by his death, and their sympathy with his family in this bereavement, have ordered that this minute be spread upon the records and that a copy be sent to his family and published in the *American Gas Light Journal* and *Progressive Age*."

Mr. William R. Beal has been elected a permanent trustee and treasurer to fill the vacancy caused by Mr. Vanderpool's death.

As the period for which the original subscriptions were made expired October 1st, 1903, it was necessary to secure new subscriptions in order to carry on the work. With this object in view there was sent to each subscriber whose subscription had expired, a letter setting forth the work that had been done and the results that had been obtained during the five years, and requesting, on the basis of these results, a renewal of the subscription for another term of five years. A similar letter was sent out later to all the gas companies in the United States and Canada and to all the members of the American Gas Light Association who were not already subscribers. As a result of these letters, copies of which are appended, subscriptions have been received to an amount which will just enable the work to be carried on, along the present lines, for five years more. The expenses are, however, even at present practically equal to the income and additional subscriptions are necessary to make it possible to take care of more students or to increase in other ways the value of the work. It is therefore to be hoped that all the old subscribers who have not yet renewed their subscriptions will do so, and that many more new subscriptions will be made. Should the income exceed the expense the surplus will be turned in to the permanent fund, which it is desired to bring up to such an amount that the interest upon it will meet all expenses and thus do away with the necessity for further subscriptions.

The work of the Correspondence Class has been carried on throughout the year. The members of the Third Section having finished the three years' course, their connection with the class ceased on April 1st, 1903. The Section of 1906 started work on January 2d, 1903, with a membership of eighty-one.

At the urgent request of one of the subscribers to the fund, a change has been made in the rules governing eligibility in the class, by which membership, instead of being restricted to employees of Gas Companies, is open also to employees of companies engaged in the manufacture of apparatus and appliances employed for the manufacture, distribution and consumption of illuminating gas.

The number of members in each section at the beginning

of the year and the changes that have taken place during the year are shown in detail on the Secretary's report, which is appended.

The Fourth Section now contains sixteen members, the Fifth Section nineteen and the Section of 1906 sixty, making the total membership in the regular class ninety-five. One special student is receiving the questions and answers with the Fifth Section and five special students are receiving the questions and answers with the Section of 1906.

The card index of gas periodicals, which has been one of the lines of work carried on by the Trustees, now covers all the principal articles published in the *American Gas Light Journal*, *Progressive Age*, and the *Journal of Gas Lighting* since 1894. It is kept up-to-date, each number of these periodicals being gone over as it is received and the necessary cards made out and filed. The value of this index to any person wishing to read up on any subject connected with the gas industry will be readily appreciated.

The Treasurer's Report, which is appended, shows the total amount of subscriptions to date, the available income and expenses for the year, a summary of the cash account and a statement of the amount of the surplus fund and the securities in which it has been invested.

The surplus fund is made up of portions of subscriptions paid in in advance of the time when they are due, of unexpended balances and of interest received on investments. The proper portion of the advance subscriptions will, of course, be drawn out each year to meet expenses, but the unexpended balances and the interest will accumulate into a fund which will be available to assist in carrying on the work in case all the present subscriptions are not renewed when they expire.

Respectfully submitted,

Trustees Gas Educational Fund,

WALTON CLARK,
Chairman.

ALFRED E. FORSTALL,
Secretary.

Secretary's Report, for Year Ending September 30, 1903.

	Third Section.	Fourth Section.	Fifth Section.	Section of 1906.	Special Class. 4th. Sec.	Special Class. 5th. Sec.	Special Class. 6th. Sec.	Total.
Members enrolled October 1, 1902	16	24	43		1	5		89
Entered Class January 1, 1903		4		81			4	89
Additions to Class since January 1, 1903		1	3	21		1	1	27
	16	29	46	102	1	6	5	205
Resigned during year	3	3	1	5			12	
Dropped for non-receipt of answers during year	2	10	26	37	1	5	81	
Finished course April 1, 1903	11						11	
	16	13	27	42	1	5		104
Total enrollment September 30, 1903		16	19	60		1	5	101

	Fifth Section.	Section of 1907.	Total.
Applications on file for admission to Class January 1, 1904	1	14	15

Names of Students Who Completed the Three Years' Course, April 1, 1903.

J. M. Berkley, Findlay, Ohio.
M. W. Butler, Philadelphia, Pa.
A. F. Kersting, Pittsfield, Mass.
A. W. Klein, Atlanta, Ga.

J. S. Norris, Montreal, Canada.
Elijah Sellen, Montreal, Canada.
E. J. Sherwood, Madison, Wis.
Wm. M. Sites, Denver, Col.
Clare N. Stannard, Denver, Col.
Wm. L. Walker, Fitchburg, Mass.
W. M. Wood, Philadelphia, Pa.

In addition to these, P. H. Gibbons, Philadelphia, Pa., and Wm. H. Miller, Bangor, Pa., answered all except the last two sets of questions.

Treasurer's Report for Year Ending September 30, 1903.

Condition of Original Subscriptions.

		Per Year.
Total amount of subscriptions October 1, 1902	$21,119.20	$4,212.84
New subscriptions received during year	462.90	92.58
Total to September 30, 1903	$21,582.10	$4,305.42
Of these subscriptions there have been paid and used during the five-year period	$21,016.90	
Leaving still in force	$565.20	
New subscriptions have been made for five years to the amount of		$4,126.00

Received from subscribers during year	$4,165.90	
Payments not applicable to year	516.32	
Total paid in by subscribers available for year	$3,649.58	
Paid in previous to current year on account of 1902-03 subscriptions	655.84	
Total subscriptions available for year		$4,305.42
Dues received from membership in special class		30.00
Sale of six sets of questions and answers for one year		30.00
Total amount available for year		$4,365.42

Statement of Income and Expenses for Year.

Total amount available for year		$4,365.42
Expenses.		
Secretary's salary	$3,000.00	
Office rent	300.00	
Furniture (filing cases and basket)	13.10	
Printing, stationery, postage, etc.	604.42	
Cuts for illustrating answers	44.26	
Total expenses paid to October 1, 1903	$3,961.78	
Add for expenses incurred but unpaid		
Printing, stationery, postage, etc.	43.75	
Total expenses for year		$4,005.53
Balance		$359.89

Cash Account for Year.

Receipts.		
Received from subscribers during year	$4,165.90	
Interest for one year on $2,000 Binghamton Gas Works 1st mtg. 5% bonds	100.00	
Interest for one year on $1,500 Atchison, Topeka and Santa Fé R. R. general mortgage 4% bonds	60.00	
Interest for 6 months on $1,000 Omaha Gas Company 1st consolidated mortgage 5% bonds	25.00	
Sale of six complete sets of questions and answers for one year	30.00	
Dues received for membership in special class	30.00	
Total receipts for year	$4,410.90	
Cash balance from last year	299.38	
Total to account for		$4,710.28

Expenditures.

Expenses for year paid	$3,961.78	
Expenses left unpaid from previous year	240.41	
		$4,202.19
Balance		$508.09
Balance in National Newark Banking Co., as per pass book, less unpaid checks		508.09

Surplus Fund and Investments.

Amounts paid in advance	$679.20
Unexpended balance from 1898-1899	1,330.99
" " " 1899-1900	397.70
" " " 1900-1901	343.71
" " " 1901-1902	211.88
Interest on bonds to date	584.72
Total	$3,548.20

Already Invested.

$2,000 Binghamton Gas Works 1st mortgage 5% bonds	$1,930.00	
$1,500 Atchison, Topeka & Santa Fé R. R. general mortgage 4% bonds	1,513.75	
		$3,443.75

Also $1,000 Omaha Gas Co. 1st mortgage 5% bonds given by Mr. Clark in renewal of his subscription.

Copy of Letter Sent to Subscribers.

In 1898 a committee appointed by the American Gas Light Association secured subscriptions, amounting to $3,193 annually for a period of five years, to be devoted to aiding and directing the efforts of the many partially educated employees of gas companies who were striving to fit themselves to occupy

positions of greater responsibility with such companies. The administration of this Fund was entrusted to a Board of Trustees, appointed by the Association. Further subscriptions were obtained by these Trustees, the income for the current year being $4,220. The period covered by the majority of these subscriptions expires October 1, 1903, and the last installments on them have been paid in. Feeling that the work carried on under their direction is of too much importance to be discontinued, the undersigned members of the Board of Trustees Gas Educational Fund request the renewal of your subscription for another term of five years, and submit, as a full and sufficient reason for such a renewal, the following statement of the results accomplished since the establishment of the Fund.

The educational work has been carried on by means of a Correspondence Class under the direction of the Secretary. A copy of the rules governing eligibility for, admission to, and continuance of membership in the class is enclosed for your information. The maximum membership in this class, 168, was reached January 1, 1903, and on March 25, 1903, the roll contained the names of 155 members, thirteen having completed the course since January 1st. The average number at work in the class during the four and one-half years has been slightly over 100. Three sections of the class have completed the course of three years. In addition to those who completed the full course, twenty-six members of the Second Section finished two years' work before being obliged, by various causes, to drop out of the class, and twenty members of the Fourth Section to enter are now beginning their third year.

Education by correspondence is not, of course, as complete and satisfactory as education in which instructor and instructed can come in personal contact, nor can a student whose only time for study is such as he can secure in the leisure left him after a day's work, cover as much ground in a year as can be covered by a student at college whose first business is study. But in this case a correspondence class is the only possible means of reaching the men it is desired to benefit, and it is gratifying to be able to state that work in the

class has proved itself of great value to the members in enabling them to fit themselves either for the promotion that has come in many cases, or for the better filling of the positions originally held. And from this fitting of their employees to perform their duties in a more efficient manner, the gas companies themselves must have derived benefit. We believe that the work of the class has returned directly to the gas companies subscribing to the Fund more than the amount of their subscriptions.

In addition to the class work a card index of the principal articles published in the *American Gas Light Journal*, *Progressive Age* and the *Journal of Gas Lighting* is kept up to date. This index extends back to 1894. It is open to subscribers and its value to any person wishing to read up on any subject connected with the gas industry will be readily appreciated. Subscribers living at a distance from New York can still avail themselves of this index by writing for lists of references upon subjects in which they are particularly interested.

The Trustees have personal knowledge of the good done by this work to many members of the class, and letters from these beneficiaries bear earnest testimony to the gratitude of men whose only opportunity for obtaining technical knowledge of their business comes through your generosity.

As the members of the class have benefited by the instruction given, through increased knowledge of their business, and in some degree through the general elevation of character inseparable from such work as they do in the class, they necessarily improve in the manner of the performance of their daily duties. The continuation of this class is therefore important alike to the men who receive its instruction and to you, whose work will be better done because of it. We therefore feel fully justified in asking for and expecting at least a renewal of your former subscription, and would suggest that it be increased by an amount proportional to the amount by which your business, and consequently your interest in the matter, has increased in the past five years. As you have been informed by the annual reports issued, the unexpended balance is put each year into a permanent fund, which, it is

hoped, will in time grow large enough to yield sufficient income to defray the cost of the work. It is therefore very desirable that the amount subscribed shall be larger than this cost, which, with the increased size of the class, will be about $5,000 per year.

Yours truly,

(Signed) WALTON CLARK, *Chairman.*
EUGENE VANDERPOOL, *Treasurer.*
W. F. DOUTHIRT,
ALEX. C. HUMPHREYS,
WM. R. BEAL,
ALTEN S. MILLER,
Trustees.

COPY OF LETTER SENT TO GAS COMPANIES AND MEMBERS OF THE AMERICAN GAS LIGHT ASSOCIATION.

In 1898 a committee appointed by the American Gas Light Association secured subscriptions, amounting to $3,193 annually for a period of five years, to be devoted to aiding and directing the efforts of the many partially educated employees of gas companies who were striving to fit themselves to occupy positions of greater responsibility with such companies. The administration of this Fund was entrusted to a Board of Trustees appointed by the Association. Further subscriptions were obtained by these Trustees, the income for the current year being $4,220. The period covered by the majority of these subscriptions expires October 1, 1903, and the last installments on them have been paid in. Feeling that the work carried on under their direction is of too much importance to be discontinued, the Trustees have secured the renewal of the greater amount of these expiring subscriptions, and, to put themselves in a position to further increase the value of this work, they request from you a subscription covering an annual payment for a term of five years. As a full and sufficient reason why such a subscription should be made, they submit the following statement of the results accomplished since the establishment of the Fund.

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copy of the rules governing eligibility for, admission to, and continuance of membership in the class is enclosed for your information. The maximum membership in this class, 168, was reached January 1, 1903, and on March 25, 1903, the roll contained the names of 155 members, thirteen having completed the course since January 1st. The average number at work in the class during the four and one-half years has been slightly over 100. Three sections of the class have completed the course of three years. In addition to those who completed the full course, twenty-six members of the Second Section finished two years' work before being obliged, by various causes, to drop out of the class, and twenty members of the Fourth Section to enter are now beginning their third year.

Education by correspondence is not, of course, as complete and satisfactory as education in which instructor and instructed can come in personal contact, nor can a student whose only time for study is such as he can secure in the leisure left him after a day's work cover as much ground in a year as can be covered by a student at college whose first business is study. But in this case a correspondence class is the only possible means of reaching the men it is desired to benefit, and it is gratifying to be able to state that work in the class has proved itself of great value to the members in enabling them to fit themselves either for the promotion that has come in many cases, or for the better filling of the positions originally held. And from this fitting of their employees to perform their duties in a more efficient manner the gas companies themselves must have derived benefit. We believe that the work of the class has returned directly to the gas companies subscribing to the Fund more than the amount of their subscriptions.

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The Trustees have personal knowledge of the good done by this work to many members of the class and letters from these beneficiaries bear earnest testimony to the gratitude of men whose only opportunity for obtaining technical knowledge of their business comes through the generosity of the subscribers to the Fund.

As the members of the class have benefited by the instruction given, through increased knowledge of their business, and in some degree through the general elevation of character inseparable from such work as they do in the class, they necessarily improve in the manner of the performance of their daily duties. The continuation of this class is therefore important alike to the men who receive its instruction, and to you, whose work will be better done because of it. We therefore feel fully justified in asking for and expecting a subscription from you and would suggest that it be made for an amount proportional to the extent of your business, which should measure your interest in the matter. The unexpended balance of income is put each year into a permanent fund, which, it is hoped, will in time grow large enough to yield sufficient income to defray the cost of the work. It is therefore very desirable that the amount subscribed shall be larger than this cost, which, with the increased size of the class, will be about $5,000 per year.

Yours truly,

ALFRED E. FORSTALL,
Secretary.

Enclosures.

APPENDIX TO REPORT OF THE TRUSTEES GAS EDUCATIONAL FUND.

(This appendix was not read at the meeting.)

Third Series of Questions, 1902—Fourth Section—Practical Class—American Gas Light Association.

1. What is crude oil? What is naphtha? What is gas oil?
2. Describe the putting into operation of a bench of retorts heated by a generator furnace, from the lighting of the fire to the putting in of the first charge, giving the precautions to be taken to prevent any injury to the setting.
3. Describe the cleaning of the washbox of a carburetted water gas apparatus, including the precautions to be observed to prevent the occurrence of any accident.
4. Give a description, illustrated by a sketch, of the manner in which to stop a small ragged hole in a gas holder sheet too thin to permit of tapping a thread.
5. What is the meaning of the term "latent heat of a vapor," and what is the value of this "latent heat" in the case of steam?
6. What is the maximum amount of gas containing 350 grains of sulphuretted hydrogen, H_2S, per 100 cubic feet that can theoretically be purified by a bushel of purifying material containing thirty-two pounds of hydrated sesqui-oxide of iron, $Fe_2O_3.H_2O$? It is assumed that no oxygen is present in the gas.
7. Give a description, illustrated by sketches, of some form of apparatus for, and the process of concentrating ammoniacal liquor and state the conditions that render it advisable to so treat the liquor.
8. A cylindrical oil tank of the "cheese-box" type is 21′ 6″ in diameter and 15′ 0″ high. How many gallons of oil will it hold for each inch and each foot of its height and what will be its total contents when full?

9. Describe some form of calorimeter by the use of which the calorific value of gas can be determined by observation.

10. State two or more conditions making the use of pressure regulators on house piping, or of governor burners, of advantage.

11. If a 4″ gas main will, under certain conditions of length of main, amount of pressure lost by friction and specific gravity of the gas, deliver 1,000 cubic feet of gas per hour, what amounts of gas will be delivered per hour under the same conditions by a 6″ main and an 8″ main respectively?

12. Describe the proper method of preparing and putting in a cement and broken stone concrete for foundations in dry or nearly dry earth.

(Answers to these questions are due October 15, 1902.)

Answers to Third Series of Questions, 1902—Fourth Section—Practical Class—American Gas Light Association.

Answers to Questions Nos. 2, 4, 5, 7 and 12 have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 2, Vol. XVIII, page 41.
No. 4, Vol. XV, page 70.
No. 5, Vol. XVI, page 84.
No. 7, Vol. XVII, page 60.
No. 12, Vol. XVII, page 115.

The answers to the other questions are as follows:

1. What is crude oil? What is naphtha? What is gas oil?

Ans. Crude oil is petroleum just as it comes from the oil wells. It is a mixture of liquid hydrocarbons possessing different chemical compositions, specific gravities and boiling points (together with small quantities of other substances)

and can be separated into these different substances by fractional distillation. It is found in nearly every country in the world, but the most important fields are in the United States, Russia and Peru. The specific gravity of the petroleum obtained in Pennsylvania and Ohio varies from .80 to .85 (or 45° to 35° Baumé), water being 1.00. The color also varies, but is generally dark claret by transmitted light and greenish by reflected light. The specific gravity of the crude oil found at Beaumont, Texas, is .91 to .92, or 24° to 22° Baumé. It is dark brown in color.

Naphtha is a general name given to that portion of the products of the fractional distillation of petroleum which comes off after gasoline has been driven off and before the fraction suitable for use as burning or lamp oils begins to come off. It is very volatile at ordinary temperatures and highly inflammable. It is practically colorless, though some samples show a decidedly greenish tinge by reflected light. Its specific gravity varies from .68 to .74, or 76° to 60° Baumé.

Gas oil is a general name given to that portion of the products of the fractional distillation of petroleum which comes off after the lamp oils and before the lubricating oils. It is too heavy and of too high a boiling point to use for lamp oil, but not viscous enough to make a good lubricant, and is chiefly valuable for the production of gas. Its color varies from quite light to very dark. Its specific gravity also varies, but will average about .84, or 37° Baumé. (Trustees.)

3. Describe the cleaning of the washbox of a carburetted water gas apparatus, including the precautions to be observed to prevent the occurrence of any accident.

Ans. There are two arrangements of washbox in water gas apparatus. In one the take-off from the washbox is on top, and in the other it is on the side and connects directly with the scrubber.

The connection from the gas outlet on top of the superheater to the washbox varies in different forms of water gas apparatus. In most cases there is a lid on top of what is known as the oil heater connection, which can be opened to clean the oil heater.

When no gas heater is used, the take-off connection from the superheater has a handhole cross at the top of the superheater, connecting the vertical riser from the washbox to the outlet branch on the superheater.

When the washbox has a take-off on top, there is a valve between the washbox and the scrubber which can be closed, and thus shut off communication between the washbox and the scrubber. In this case, first open either the lid on top of the oil heater, or, in case there is no oil heater, the handhole on the cross; then shut off the overflow from the washbox to the seal pot, open the handhole on top of the washbox and fill the washbox with water. When the washbox has been filled, draw off the water, open the handhole or manhole on side of washbox and remove the tar, etc.

In case the washbox is joined to the scrubber by a side outlet, and there is no valve between them, the gas valve at the outlet of the scrubber must be closed. The stop cock on the overflow pipe from the scrubber must now be shut and the manholes on the scrubber opened, beginning with the one on top and working downward. The openings on the take-off pipe from the superheater to the washbox and the handhole on top of the latter must also be opened up, and the washbox filled with water until this rises into the stand-pipe above the top of the box. This, of course, involves filling the scrubber also to an equal height. Before emptying the washbox the stand-pipe should be thoroughly cleaned of all carbon and tar to remove all danger of its catching fire and igniting any gas that might work back from the scrubber when the water is run out. If any of the carbon should happen to be on fire when it is scraped down it will be extinguished by falling into the water, and before the water is drawn off care must be taken to see that none remains unextinguished. After the stand-pipe has been cleaned it should be plugged, just below the connection to the superheater, with either a bag of wet sawdust or a board cut to fit in fairly tight, and plastered around the edge with fire clay to close all cracks. The object of this plugging is to prevent any gas that may work back from the scrubber from being ignited at the top of the superheater. The water can now be run off the washbox and scrubber and the washbox opened and cleaned.

The differences between the two methods are called for by the necessity of seeing that the scrubber is thoroughly ventilated when it cannot be shut off, and of taking precautions to prevent the ignition of any gas that may still remain in the scrubber in spite of the ventilation given it. *In any case the washbox and its connections must be thoroughly ventilated, and it should be provided that no fire comes near the washbox or its connections, or the scrubber, while they are open, and that no light is used about the work.* (Trustees.)

6. What is the maximum amount of gas containing 350 grains of sulphuretted hydrogen, H_2S, per 100 cubic feet that can theoretically be purified by a bushel of purifying material containing thirty-two pounds of hydrated sesqui-oxide of iron, $Fe_2O_3.H_2O$? It is assumed that no oxygen is present in the gas.

Ans. The answer to Question No. 6 of the First Series of Questions for 1902 shows that each pound of hydrated sesqui-oxide of iron, $Fe_2O_3.H_2O$, will combine with 0.573 pound of sulphuretted hydrogen, H_2S. Therefore, the thirty-two pounds of oxide contained in a bushel of the purifying material specified can theoretically absorb $32 \times 0.573 = 18.34$ pounds of sulphuretted hydrogen. Since the gas contains 350 grains of sulphuretted hydrogen per 100 cubic feet, it will contain 3,500 grains, or 0.5 pound (one pound equals 7,000 grains) per 1,000 cubic feet. $18.34 \div 0.5 = 36.68$; hence, a bushel of purifying material containing thirty-two pounds of hydrated sesqui-oxide of iron will theoretically purify, during one exposure, 36,680 cubic feet of a gas which contains 350 grains of sulphuretted hydrogen per 100 cubic feet.

Obviously, the amount of gas that can be purified will vary according to the quantity of H_2S in the gas, and also according to the weight of $Fe_2O_3.H_2O$ contained in a bushel of material.

It is also possible by admitting oxygen with the gas, and thus securing a continuous partial revivification, to purify more gas to an exposure than is indicated by the method of calculation given above. Unless oxygen is supplied, however, the duty actually obtained in practice from any material will

always be less than the theoretical amount obtained by calculation, as it is impossible, under working conditions, to thoroughly saturate with H_2S all the $Fe_2O_3.H_2O$ in the material. (Trustees.)

8. A cylindrical oil tank of the "cheese-box" type is 21′ 6″ in diameter and 15′ 0″ high. How many gallons of oil will it hold for each inch and each foot of its height, and what will be its total contents when full?

Ans. The area of a circle 21′ 6″ or 258″ in diameter is, as obtained from the tables of circumferences and areas of circles, 52,279 square inches, and therefore the tank will contain a volume of 52,279 cubic inches for each inch of its height. An American gallon has a volume of 231 cubic inches. $52{,}279 \div 231 = 226.3 +$ so each inch in height of the tank will contain 226.3 gallons of oil.

Each foot in height will contain $226.3 \times 12 = 2715.6$ gallons, and the total contents of the tank when full will be $2715.6 \times 15 = 40{,}734$ gallons.

Using the contents per inch and per foot, determined as above, a table should be prepared for each oil tank at a gas works, showing the total contents for any height to which it is filled with oil from 1″ to the full height. (Trustees.)

9. Describe some form of calorimeter by the use of which the calorific value of gas can be determined by observation.

Ans. The calorimeter that is most commonly used in this country for determining, by observation, the calorific value of gases, is an improved form of the Hartley Calorimeter designed by Hugo Junker, and known as the Junker Calorimeter. It acts by transferring the heat developed by the combustion of a measured quantity of gas to a measured quantity of water which flows at a constant rate through the apparatus.

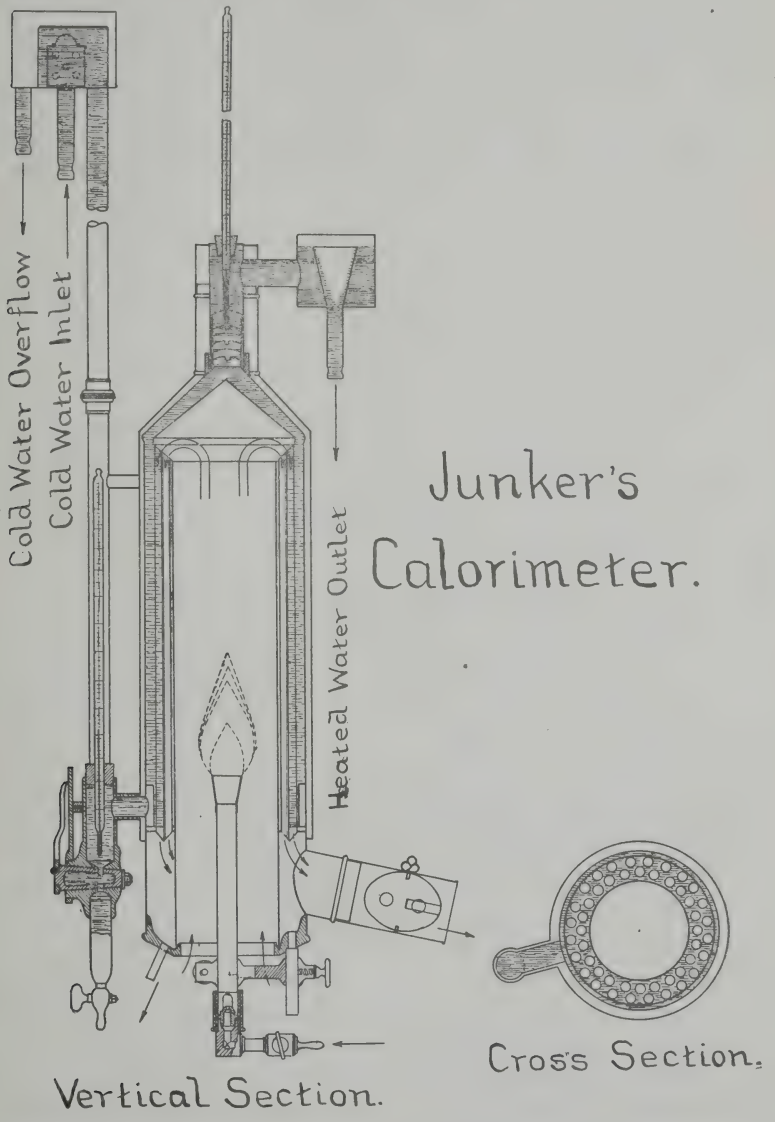
The calorimeter itself is an annular vessel made of two concentric copper cylinders, the outer cylinder having a diameter of about seven inches and the inner one a diameter of about four inches. To the top of the outer cylinder is fitted a conical hood which closes the whole top of the vessel, except for a circular opening left at the apex of the cone. A smaller hood which begins as a frustrum of a cone with its base upwards and then

changes to a cone with its apex upwards, is attached to the inner cylinder so that the annular space is continued up between the two hoods and the space within the inner cylinder is shut off at the top from this annular space. The bottom of the inner cylinder is left open and the bottom of the annular space is closed by a ring. At a distance of four or five inches above this ring is fastened another ring forming a water-tight partition which divides the annular space into two compartments. Through the upper one of these two compartments pass a number of small copper tubes, the upper ends of which are fastened to the diverging cone of the inner hood while the lower ends are fastened to the partition described above. The joints between the tubes and the hood and partition must be water-tight.

Into one side of the outer cylinder, just above the bottom of the upper compartment, opens a copper pipe set at a right angle to the axis of the cylinders. This pipe enters the side outlet of a tee piece set with its run vertical and about two inches from the cylinder. From the lower outlet of the tee the pipe is dropped a short distance and then passing around a U shaped turn rises to a height of about 20″ above the top of the annular vessel and ends in a small cistern or cup formed inside of a larger one, both cups having a common bottom supported by the pipe. To the part of this bottom covered by the small cup is attached a corrugated nipple, over which a rubber tube can be slipped, and a similar nipple is fastened in the space outside of the small cup. The upper outlet of the tee is closed by a rubber cork pierced for the insertion of a thermometer. A stop cock provided with an arrow-shaped handle, moving over a graduated quadrant, is placed between the tee and the bend. Opposite the opening of the pipe in the outer cylinder is placed a baffle plate forming a small annular space extending completely around the cylinder, the object of which is to cause the water entering through the pipe to be uniformly distributed all around the annular chamber.

To the circular opening left, as described above, at the apex of the outer hood is fitted a copper tube provided with several baffle rings with centre openings. This tube ends in a tee piece, the upper end of which is closed by a cork pierced for

a thermometer, and from the side outlet of this tee runs a pipe which ends, in and supports by its side, a cup. Inside



the cup is a funnel ending in a nipple for tubing, which passes through and is fastened with a water-tight joint to the bottom of the cup.

On one side of the lower compartment of the annular space is an elliptical opening leading into a tube of the same cross section. Provision is made for the insertion of a thermometer into this tube as close as possible to the outer cylinder, and it is also fitted with an ordinary stove pipe damper. At a point diametrically opposite to this tube a small tube is tapped into the bottom ring, and directly under it is tapped in a rod which serves to support the burner through which the gas is consumed.

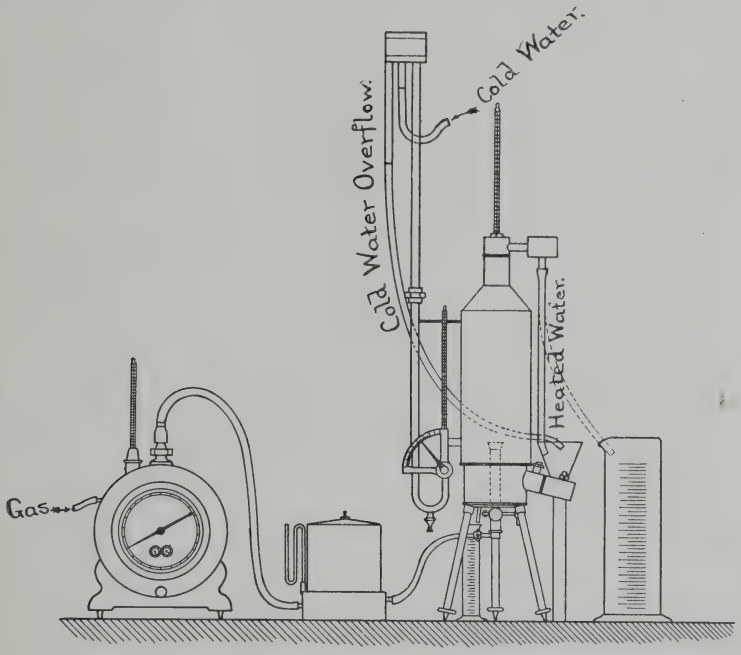
To prevent loss of heat by radiation the whole of the body of the calorimeter above a point an inch or two below the bottom of the upper compartment is jacketed by a highly polished nickel-plated copper cylinder made sufficiently large to leave an annular air space one-half inch wide between it and the calorimeter.

When set up, the apparatus stands on three removable legs provided with levelling screws. Reference to the accompanying sections of the calorimeter will, in connection with the above description, enable the construction of the apparatus to be fully understood.

Two measuring glasses are provided with the calorimeter. The larger one will hold two litres and is graduated in intervals of five cubic centimetres. The other is an ordinary 100 cubic centimetre glass, graduated to one-half of a centimetre. (A litre is 1,000 cubic centimetres, and a litre of water weighs one kilogram.)

When it is desired to make a determination of the calorific value of a gas, the apparatus is set up on a firm base in such a position that it can be readily supplied with the gas to be tested and with flowing water. The thermometers provided for the purpose, which are graduated in tenths of degrees Centigrade from 0° to 50°, should be inserted in the proper openings, as described above. Connection is then made to the water supply by means of rubber tubing slipped over the nipple on the bottom of the smaller inside cup of the two supported by the pipe which enters the calorimeter at the bottom of the upper compartment. A rubber tube leading to a drain is slipped over the nipple opening from the larger cup in the space outside the small one, and another pipe is

slipped on the nipple leading from the funnel in the cup supported by the pipe coming out of the tube at the top of the conical hood. Water being turned on flows into the small cup and thence down through the pipe, around the U bend, up through the stop cock, around the bulb of the thermometer inserted into the tee and into the annular space around the tubes. It rises through this space and passes up the central tube, in which it is thoroughly mixed by the baffle rings, over



Junker's Calorimeter and Auxiliary Apparatus set up ready for Use.

the bulb of the thermometer inserted into the tee at the top of the tube and thence by the side pipe to the cup in which it rises until it overflows into the funnel and passes away by a rubber tube slipped over the funnel nipple. By admitting water into the small cup at a faster rate than that at which it is admitted to the calorimeter, this cup is filled and water

overflows from it into the larger cup from which it runs off through the nipple and tube to the drain. In this way a constant head for the supply of water is maintained and as the water also overflows into the funnel on the outlet at a constant height, the effective head is constant and the water must flow through at a constant speed as long as the stop cock remains set at any given opening.

The gas to be consumed is led to the apparatus through an experimental meter, by which it is measured, and a sensitive governor, by which the pressure, and consequently the rate of flow for any given opening of the stop cock, is kept constant. For illuminating gas a bunsen burner is used and the gas is burned at the rate of five to six cubic feet per hour. After being lighted the burner is placed inside the inner cylinder and clamped to the rod provided for this purpose. The clamp arm is of such a length and the rod is so flattened that when the set screw is tightened the axis of the burner coincides with the axis of the calorimeter, and it is fastened at a height that brings the bottom of the flame five to six inches above the lower edge of the apparatus.

The products of combustion rise inside the inner cylinder until they strike the inner hood and then pass down through the tubes to the lower annular compartment and out through the outlet flue to the air. In the passage up the inside of the cylinder and through the tubes they impart their heat to the water surrounding the tubes and emerge from the apparatus at a temperature either exactly or very nearly that of the air. Any water vapor formed by the combustion of the gas is condensed and runs off through the small pipe tapped into the ring closing the bottom of the lower annular compartment.

To make a test, water is started flowing through the apparatus, and the gas burner lighted and put in place and the flow of gas adjusted to the proper rate. The flow of water is then adjusted by the graduated stop cock to a rate that will give the desired difference in temperature between the outgoing and incoming water. This difference is usually kept between 10° and 20° C. When the temperature of the outgoing water, as shown by the thermometer at the top of the calorimeter, is at the desired point and remains constant, and

the condensed water has begun to drop from the tube at the bottom, a test can be made. The hand of the meter must be watched and as it passes the zero mark the end of the tube through which the heated water is flowing must be inserted in the large graduated measure and the small measure placed under the condensed water outlet. Four or five observations of the temperatures of the water as it enters and leaves the apparatus must be made and recorded at regular intervals. When the meter hand crosses the zero mark after making either one or two revolutions, depending upon the rate at which the water is flowing, the hot water tube must be removed from the measure and the water allowed to run to waste again. The observed temperatures are then averaged and the difference between the outlet and inlet temperatures obtained. The amount of water collected in the measuring glass is read off in cubic centimetres by means of the scale marked on the glass, and this amount reduced to litres and decimals of a litre by dividing by 1,000, or pointing off three decimal places. Since a calorie is the quantity of heat required to raise the temperature of one kilogram of water 1° C. and a litre of water weighs one kilogram, the product obtained by multiplying the amount of water collected, measured in litres, by the number of Centigrade degrees by which its temperature is raised, is the number of calories absorbed by the water and consequently the number produced by the combustion of the measured quantity of gas. This number can be changed to British thermal units by multiplying it by 3.968, one calorie being equal to that number of British thermal units, and from this figure and the quantity of gas used the calorific value of the gas in British thermal units per cubic foot can be readily found.

The result so obtained is the gross calorific value of the gas, the water formed having been condensed in the calorimeter, and it is to enable the net calorific value to be determined that this condensed water is collected and measured. The amount can be measured for each test, but since the quantity is comparatively so small that the unavoidable error in reading amounts to a large percentage, it is best to allow one cubic foot of gas to be burned and use the amount of condensed

water collected during the combustion of this quantity of gas as an average to be employed for each of the different tests made at that particular time. Having the amount of condensed water, the latent heat of the steam corresponding to it can be calculated and deducted from the gross heating value to obtain the net heating value of the gas under test. A convenient rule is that for every cubic centimetre of water so condensed per cubic foot of gas burned, a deduction of .6 calorie, or 2.382 British thermal units must be made from the gross calorific value per cubic foot to obtain the net calorific value.

When it is necessary to have very exact results, the temperature of the gases issuing from the calorimeter must be made the same as that of the gas passing through the meter, and the water collected should be measured cold. (Trustees.)

10. State two or more conditions making the use of pressure regulators on house piping, or of governor burners, of advantage.

Ans. First. A wide variation in the pressure at the meter, such as will be found on feed mains running from the works, or holder stations, to different parts of the district supplied, since to keep up the pressure at far-away points, it is necessary, at the times of maximum demand, to carry a much higher pressure on these mains than is required at the times of smaller demand.

Second. A pressure at the burner higher than is consistent with the economical use of gas, such as will be found at the higher points of very hilly districts.

Where these conditions exist, and especially where the one first mentioned is found, it is very difficult to get satisfactory results from gas burners, particularly if they are incandescent burners, without the use of a pressure regulator at the outlet of the meter, or of governors on the burners. (Trustees.)

11. If a 4″ gas main will, under certain conditions of length of main, amount of pressure lost by friction and specific gravity of the gas, deliver 1,000 cubic feet of gas per hour, what amount of gas will be delivered per hour under the same conditions by a 6″ main and an 8″ main respectively?

Ans. The formula by which the amount of gas flowing through pipes under different conditions can be calculated is $Q = 1{,}350\sqrt{\frac{d^5 p}{sl}}$ in which Q is the number of cubic feet of gas delivered per hour, d is the diameter of the pipe in inches, p is the pressure required for overcoming the friction in the pipe, s is the specific gravity of the gas, and l is the length of pipe in yards. From this formula it will be seen that the amount of gas delivered will, everything else remaining the same, vary as the square root of the fifth power of the diameter of the pipe in inches. The fifth power of 4 is 1,024 and the square root of this is 32, the fifth power of 6 is 7,776 and the square root of this is 88.18, and the fifth power of 8 is 32,768, the square root of which is 181. Therefore, the carrying capacities of 4″, 6″ and 8″ pipes are to each other, all other conditions being the same, as 32 to 88.18 to 181, or as 1 to 2.76 to 5.66. That is, if a 4″ main will, under certain conditions of length, amount of pressure lost by friction and specific gravity of the gas, deliver 1,000 cubic feet of gas per hour, a 6″ main will, under the same conditions, deliver 2,760 cubic feet per hour, and an 8″ main 5,660 cubic feet per hour.

The problem can also be solved with a gas flow computer by setting the figure 4 on the diameter-of-pipe scale opposite the figure 1,000 on the cubic-feet-of-gas-per-hour scale and reading off on this latter scale the figures that stand opposite 6 and 8 on the diameter-of-pipe scale.

The same relation holds for pipes of any diameters that are to each other in the ratio 4, 6 and 8, or, what is the same thing, the ratio 2, 3 and 4. Thus, a 12″ pipe will carry 2.76 times and a 16″ pipe 5.66 times as much gas as an 8″ pipe. (Trustees.)

THIRD SERIES OF QUESTIONS, 1902—THIRD SECTION—PRACTICAL CLASS—AMERICAN GAS LIGHT ASSOCIATION.

1. It is found by test at a certain gas works that when using anthracite coal in the generator of the carburetted water gas apparatus the generator fuel amounts to 33 lbs. per 1,000 cu. ft. of carburetted gas made and the rate of make is 12,000

cu. ft. per hour, while when a certain furnace coke is used the generator fuel amounts to 35 lbs. per 1,000 cu. ft. and the rate of make is only 10,000 cu. ft. per hour. The price of the coal is $5.00 per gross ton and the wages of the gas maker are 20 cents per hour. What would be the equivalent price per gross ton of the coke, all items affecting the cost of the gas which are not mentioned above being considered equal in the two cases?

2. How would you make a working test of the proportion of volatile matter and coke in any sample of coal?

3. Give a description, illustrated with sketches, of some form of apparatus for concentrating ammoniacal liquor. Describe the process of concentrating the liquor and state the conditions that render it advisable to so treat the liquor.

4. How can the weight of water evaporated per pound of fuel by a boiler under ordinary working conditions be determined approximately?

5. How would you determine the area of the purifying boxes required to purify economically any given amount of gas per twenty-four hours?

6. Give your theory of the causes of stoppages in the stand-pipes of coal gas retorts and the means you would employ to prevent them.

7. Describe the proper treatment of iron oxide from the time it is taken out of the box for revivification until it is again returned to the box.

8. What is the maximum amount of gas containing 0.50 per cent. by volume of H_2S that can theoretically be purified during continuous exposure by a bushel of purifying material weighing 50 lbs. and containing 66 per cent. by weight of $Fe_2O_3.H_2O$? It is assumed that no oxygen is present in the gas. Give all calculations.

9. How would you proceed to locate an obstruction in the distribution system of your town, the presence of which is indicated by a general complaint of poor supply in a district which is fed from several points and in which the pipes are

large enough to properly supply the demand if no obstruction exists?

10. How would you repair a leak resulting from a broken main? Give a full description of the fittings used and the manner in which these fittings should be applied to the main in order to make the repair complete and permanent.

11. What are the conditions leading to efficiency of working in a gas engine?

12. What are the precautions that should be taken in laying fire brick and fire clay blocks to secure for the finished work strength and the ability to resist heat?

(Answers to these questions are due November 17, 1902.)

Answers to Third Series of Questions, 1902—Third Section—Practical Class—American Gas Light Association.

Answers to all of these questions, except Nos. 1, 5, 8, 9 and 10, have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 2, Vol. XVII, page 47.
No. 3, Vol. XVII, page 60.
No. 4, Vol. XVII, page 25.
No. 6, Vol. XVI, page 76.
No. 7, Vol. XVI, page 55.
No. 11, Vol. XVI, page 64.
No. 12, Vol. XVIII, page 64.

The answers to the other questions are as follows:

1. It is found by test at a certain gas works that when using anthracite coal in the generator of the carburetted water gas apparatus, the generator fuel amounts to 33 pounds per 1,000 cubic feet of carburetted gas made and the rate of make is 12,000 cubic feet per hour; while when a certain furnace coke is used the generator fuel amounts to 35 pounds per 1,000 cubic feet and the rate of make is only 10,000 cubic feet per hour. The price of coal is $5.00 per gross ton, and the wages of the gas maker are 20 cents per hour. What

would be the equivalent price per gross ton of the coke, all items affecting the cost of the gas which are not mentioned above being considered equal in the two cases?

Ans. Since, as stated in the question, the items of generator fuel and gas maker's labor are the only ones to be considered, the price of coke equivalent to a price of $5.00 per gross ton for anthracite coal must be such that the total cost of gas maker's labor and generator fuel per 1,000 cubic feet of gas made will be the same in each case.

In the case of the coal, under the conditions stated in the question, 33 pounds costing $\frac{500}{2240} = 0.223$ cent per pound, are required for generator fuel per 1,000 cubic feet of gas made, so the cost of this fuel will be $33 \times 0.223 = 7.36$ cents per 1,000 cubic feet. The cost of gas maker's labor is 20 cents per 12,000 cubic feet, or $\frac{20}{12} = 1.67$ cents per 1,000 cubic feet. The total cost for generator fuel and gas maker's labor is therefore 9.03 cents per 1,000 cubic feet.

When using coke the gas maker's labor will cost 20 cents per 10,000 cubic feet, or 2 cents per 1,000 cubic feet. The price at which coke must be bought to be equivalent to coal at $5.00 per ton is therefore $9.03 - 2.00 = 7.03$ cents for the amount, 35 pounds, required as generator fuel per 1,000 cubic feet of gas made. This is equal to a price per pound of $\frac{7.03}{35} = 0.201$ cent, or a price per gross ton of $4.50. (Trustees.)

5. How would you determine the area of the purifying boxes required to purify economically any given amount of gas per twenty-four hours?

Ans. As four-box sets of purifiers are, for many good reasons, the most commonly adopted, this answer treats of such sets only.

The proper area to be given purifying boxes in four-box sets, in order that they may purify economically a certain amount of gas, is determined by empirical rules that have been deduced from the results of experience. The rule that is commonly accepted as correct in England is given in the Sixth Edition of Newbigging's Handbook as follows: "Where there is intended to be four purifiers, three always in action, the maximum daily (24 hours) make of gas, expressed in thou-

sands, multiplied by the constant 0.6, will give the superficial area in feet of each purifier." According to this rule there must be provided 60 square feet of area in each box for every 100,000 cubic feet of gas to be purified per twenty-four hours. As it is not stated what purifying material is to be used in the boxes, it is to be presumed that the rule is intended to apply to both lime and oxide of iron.

Since the quantity of sulphuretted hydrogen and other sulphur compounds in the gas determines the amount of work to be done in the purifiers, and the English gas coals contain more sulphur, on an average, than the American coals, the English rule may very possibly give an area that is larger than it is necessary to have in this country. For although the work done by a bushel of lime, or a bushel of oxide of iron, per change (which in the case of lime is the whole amount of work obtained) increases with an increase in the ratio between the area of the boxes and the amount of gas to be purified per day, and the cost of labor per 1,000 cubic feet (and in the case of lime of material also) is thus reduced, the increase in size carries with it an increase in the fixed charges for interest and depreciation on the cost of the purifiers and of the house in which they are enclosed, which must sooner or later balance the reduction in operating expenses. The most economical area is therefore that which gives the smallest total for the costs for labor and material and the fixed charges.

The Trustees are not aware of anything having been published, in which the question of the balancing of these two items of cost against each other is treated with regard to purification by lime, so for lime purifiers there are no data from which to determine whether the rule given by Newbigging is correct for American conditions. The cost of labor and material being larger with lime than with oxide, lime purifiers must be made larger than oxide purifiers to obtain the most economical results, but with the present knowledge it cannot be said exactly how much larger they should be.

For purification with oxide of iron, the subject of the most economical size of purifiers for use with carburetted water gas has been investigated by Mr. J. A. P. Crisfield, and the results obtained are given in a paper read by him in October, 1893,

before the American Gas Light Association, and published in the Proceedings of the Association, Vol. X, page 217, and in the American Gas Light Journal, Vol. L, page 653, and Progressive Age, Vol. XI, page 356. By means of experiments conducted on a working scale, Mr. Crisfield determined the amounts of gas purified, during one exposure, per cubic foot of oxide for different lengths of time taken by the gas to pass through the oxide contained in three boxes of a four-box set, and also the cost of the labor required to remove the oxide from and replace it in the boxes. From these data the cost of purifying labor per 1,000 cubic feet could be calculated for each length of time that the gas remained in contact with the oxide. The cost of material was not considered; but since with oxide this cost is very small, and is probably not very much affected by the amount of work done per change, it is not important. By combining with the costs of labor the costs of interest and depreciation on the estimated values of the various sized purifiers and purifying houses that would be required to cause gas passing at an assumed rate per hour to stay in contact with the oxide the different lengths of time for which the cost of labor had been obtained, the conclusion was reached that the most economical length of the time of contact was forty-eight seconds. However, in order to provide for the use of oxide of iron less efficient than that used in his experiments, Mr. Crisfield gave the following rule for determining the most economical size of purifying boxes for use with oxide of iron, this rule being based upon a time of contact of sixty seconds. "$60 = \frac{3600V}{3R}$ where V is the volume of oxide" (in cubic feet) "between inlet of first box and point of testing gas and R is the rate" (of make) "per hour. By substitution of the desired rate per hour V becomes known: divide V by 2 or 3, dependent upon whether it is the intention to test on second or third box, and the result is the volume of oxide in one box which may be put into any length, breadth and depth that is convenient.

"The equation may be simplified for convenience to read $R = 20\ V$. Or the volume of oxide between the inlet to the purifiers and the point of treating for sulphuretted hydrogen should be 1/20 of the rate per hour."

Mr. Crisfield apparently intended that the average rate of make throughout the year should be used in this formula, since it is in this way that it has been used to determine the sizes of the boxes necessary. But if this is done, when the make is at the maximum the time of contact falls below the number of seconds stated by him as the limit below which the oxide ceases to do any work. It would seem, therefore, as if the maximum rate of make should be used instead of the average. Assuming the boxes to be worked three on and one off, as is customary, and the oxide to be in a layer 30″ deep in each box, as can easily be accomplished in boxes 4′ deep, even when a catch layer of shavings is used below the layer of oxide, the rule gives the area required in each box as 42 square feet per 100,000 cubic feet of the maximum twenty-four hours make. If the valve arrangement is such as to permit of all four boxes being worked at once, so that the gas can be tested at the outlet of the third box, the area given by this rule is only 28 square feet per 100,000 cubic feet of the maximum twenty-four hours make.

Mr. Crisfield's experiments having been made with carburetted water gas, which contains less sulphuretted hydrogen than does coal gas, the area determined by his rule is too small for coal gas work. A common practice is to make the boxes for coal gas work 33⅓% larger than those for carburetted water gas work, an area (in square feet) equal to the maximum make (in 1,000 cu. ft. per 24 hours) multiplied by 0.3 being taken for the latter, while the area for the former is reached by the use of the factor 0.4.

In designing a new set of purifiers it is necessary to make a proper allowance for the probable increase in the amount of gas made, and to take as the maximum make to be provided for, not the make at the time, but such an one as circumstances indicate will be reached within a reasonable time. Proper allowance must also be made when it is known that the gas making materials that are to be used contain an unusually large percentage of sulphur. (Trustees.)

8. What is the maximum amount of gas containing 0.50 per cent. by volume of H_2S that can theoretically be purified during continuous exposure by a bushel of purifying material

weighing 50 pounds and containing 66 per cent. by weight of $Fe_2O_3.H_2O$? It is assumed that no oxygen is present in the gas. Give all calculations.

Ans. Since the purifying material is assumed to weigh 50 pounds per bushel and to contain 66 per cent. by weight of ferric hydrate ($Fe_2O_3.H_2O$), each bushel will contain $50 \times 0.66 = 33$ pounds of $Fe_2O_3.H_2O$.

According to the answer to Question No. 6 of the First Series for 1902, the reactions on which the removal of sulphuretted hydrogen (H_2S) from gas by $Fe_2O_3.H_2O$ chiefly depend are as follows:

$$Fe_2O_3.H_2O + 3H_2S = Fe_2S_3 + 4H_2O.$$
$$Fe_2O_3.H_2O + 3H_2S = 2FeS + S + 4H_2O.$$

The proportion between $Fe_2O_3.H_2O$ and H_2S being the same in both of these equations, the amount of H_2S absorbed by a given quantity of $Fe_2O_3.H_2O$ will be the same no matter what combination of the two reactions actually occurs.

The atomic weight of iron (Fe) being 56, and that of oxygen (O) 16, that of hydrogen (H) 1, and that of sulphur (S) 32, we have $Fe_2O_3.H_2O = (2 \times 56) + (3 \times 16) + (2 \times 1) + 16 = 178$ and $3H_2S = 3(2 \times 1 + 32) = 3 \times 34 = 102$. Therefore 178 parts by weight of $Fe_2O_3.H_2O$ will combine with 102 parts of H_2S or 1 pound will combine with $\frac{102}{178} = 0.573$ pound, and 33 pounds of $Fe_2O_3.H_2O$ will combine with $33 \times 0.573 = 18.909$ pounds of H_2S. But one pound of dry H_2S at 60° F. and 30″ barometer occupies a volume of 11.1229 cubic feet, so 18.909 pounds will correspond to $18.909 \times 11.1229 = 210.32$ cubic feet of H_2S.

As the gas is assumed to contain 0.50 per cent. by volume of H_2S it will contain 5.0 cubic feet of H_2S per 1,000 cubic feet. $\frac{210.32}{5.0} = 42.064$, and therefore 42,064 cubic feet is the maximum amount of gas containing 0.50 per cent. of H_2S that can theoretically be purified during one exposure by a bushel of purifying material weighing 50 pounds and containing 66 per cent. by weight of $Fe_2O_3.H_2O$. Obviously this amount will vary according to the weight of $Fe_2O_3.H_2O$ contained in a bushel of material.

It is also possible by admitting oxygen with the gas, and thus securing a continuous partial revivification, to purify more gas to an exposure than is indicated by the method of calculation given above. Unless oxygen is supplied, however, the duty actually obtained in practice from any material will always be less than the theoretical amount obtained by calculation, as it is impossible, under working conditions, to thoroughly saturate with H_2S all the $Fe_2O_3.H_2O$ in the material. (Trustees.)

9. How would you proceed to locate an obstruction in the distribution system of your town, the presence of which is indicated by a general complaint of poor supply in a district which is fed from several points and in which the pipes are large enough to properly supply the demand if no obstruction exists?

Ans. It is assumed, as a matter of course, that all the drips in the various mains supplying the district have been gone over, as soon as attention is called to the trouble, to make certain that it does not arise from a flooded drip due to an unusual cause that has developed since the time of the last periodical examination, and that they have been found all right.

This possible cause having been eliminated from the problem, the next step is to determine which of the several feed mains, by which the district is supplied, is the one that is obstructed. To do this it is necessary to observe the pressures, at the time of heavy consumption in the district, at a series of points along each of the mains, using for the purpose lamp post pipes, or special pressure pipes, if either exist, or else the pumping pipes on drips that are suitably located, or as a last resort the consumers' services. If recording gauges are available in sufficient number, they can be used and will give a means of comparing the pressures at the various points during the whole time of heavy consumption; but if they are not available the desired information can be obtained by the use of ordinary syphon gauges in the following manner. Observations must be taken at, at least, two consecutive points simultaneously. The gauge farthest along in the direction in which

the work is being done, which should be that in which the gas is expected to flow, is then left in place, while the other gauges are moved to the points next in succession and another set of simultaneous observations taken, this process being repeated until the whole length of the pipe has been covered.

When the pressures have to be taken from the services with syphon gauges, all the requisite preparatory work should be done in the day time so that there will be nothing to do in the evening except to attach the gauges and take the observations. The amount of gas being used through each service, at the time the pressure is observed, should be noted, to determine whether any allowance should be made for a reduction in pressure on this account. Any other causes, such as differences in elevation, that would normally affect the pressure, must also be taken into consideration, and an allowance made for their effect.

The location of the points at which the pressures are to be taken will depend largely upon the special conditions existing in any system ; but, in the absence of any reason to the contrary, they should be selected so that the pressures should, under normal conditions, show as nearly as possible equal drops between consecutive points.

If no obstruction exists in the main being tested, the pressure will show a gradual and uniform decrease at each point, and if the observed pressures decrease in this way, the pipe is thus shown to be free from obstruction. An obstruction, by causing the flow of gas through the pipe to be below the normal amount, will cause the pressure to show practically no reduction up to the place at which the obstruction is located, with a sharp drop, equal to almost the whole loss, as soon as the obstruction is passed. When these conditions are observed on one of the mains, it is certain, not only that the obstruction that is being sought for is in this main, but also that it is located between the two points showing the large difference in pressure. The exact location can then be found by taking the pressures at various points between those determined as above, the points being taken closer and closer together until the drop in pressure is located between the two consecutive available points that are nearest to each other. When this has been

done, the main must be uncovered at a point midway between those at which the pressures were last taken, a hole tapped in the pipe and the pressure taken to determine on which side of this hole the obstruction is to be sought. A stout wire can then be inserted, in the proper direction, to determine whether the obstruction is within striking distance, and, if so, its exact location and nature. If it cannot be located in this way, the main must be uncovered at another point, midway between the last point, and that one of the points previously taken which shows the marked difference in pressure, a hole tapped, the pressure taken and the wire used, this being repeated until the exact location of the obstruction is found.

The above method, which requires that the taking of pressures be done during the time of maximum consumption, that is, usually in the early evening, is the only one that can be employed when the day consumption is comparatively small. When the day consumption is relatively large, the line in which the obstruction exists can be determined in the day time by bagging off the feed mains, one after another, at points as far removed from the centre of the district as possible, noting, in each case, the pressure at some point in the district, both before and after the bag is put in. If a main is doing its share of the work of supplying the district, stopping it off will cause an appreciable reduction in the pressure, while if it is already obstructed the effect of a complete shutting off will not be marked. If, therefore, the pressure shows no decided change when one of the mains is bagged, the obstruction is to be sought in that main, and its position can be located by bagging at several points in succession, and noting in each case the drop in pressure on each side of the bag when gas is allowed to escape from the pipe through the bag hole, the bag being put first to one side of the hole and then to the other. As long as the obstruction has not been passed, the flow of gas induced in this way will cause only a slight drop on the side towards the feed, and a larger one on the side towards the district. As soon as the pipe is bagged on the district side of the obstruction the drop in pressure will be almost the same on both sides, and the obstruction must be looked for between the first hole at which this is observed and the last hole at which normal

conditions were found to exist. This method of bagging the mains is especially useful where no services are taken off the feed mains for some distance before the affected district is reached.

The character of the steps to be taken to remove the obstruction will depend upon its nature. If it is an accumulation of water due to a sag in the main, all that is required is the regrading of the main, while if it is a solid obstruction that cannot be removed by the use of solvents, it may be necessary to cut the main before it can be cleared. (Trustees.)

10. How would you repair a leak resulting from a broken main? Give a full description of the fittings used and the manner in which these fittings should be applied to the main in order to make the repair complete and permanent.

Ans. The main having been uncovered and the break located, the escape of gas should be stopped temporarily, by pressing either clay or soap into the crack. The further procedure depends upon whether the break runs around the pipe so as to be all included within not over four or five inches in length, or extends longitudinally for a greater distance than this. In the first case the repair can be made with a split sleeve; in the second the cracked piece must be cut out and a new piece inserted.

When a split sleeve is to be used, all dirt and rust must be scraped off the pipe for a distance of a foot on each side of the break, and if the pipe has settled it must be brought back to the proper grade and alignment. A strip of unbleached muslin, wide enough to cover the break with a margin of three or four inches on each side and long enough to wind completely around the pipe several times, is smeared with a putty made of white lead, or equal parts of white and red lead, and linseed oil, and wrapped tightly around the pipe over the break. This serves to entirely prevent the escape of gas while the job is being completed. A split sleeve, that is, a sleeve made in two pieces, each of them similar in size and shape to the pieces that would be obtained by splitting a solid sleeve along a plane containing both its axis and a diameter and provided with longitudinal flanges by which they can be bolted together, is

then applied so as to cover the pipe at the break and for at least three or four inches on each side of it. The joint between the split sleeve and the pipe can be satisfactorily made in various ways.

One method is to plaster the inside of each half of the sleeve with a layer of Portland cement, mixed neat, of sufficient thickness to insure the complete filling of the joint and the compacting of the cement without allowing the flanges to come face to face when the two parts are put over the pipe and drawn together by means of the bolts. Enough cement should squeeze out through the spaces between the flanges to fill them thoroughly; but if this does not occur any unfilled places can be pointed up, so that, when the job is completed and the cement has set, the two halves of the sleeve are joined together with a gas tight joint by the cement between the flanges.

Another method is to make the joints between the flanges gas tight by using strips of millboard that have been soaked in hot water until they have become soft enough to be squeezed into all the roughnesses of the faces of the flanges when the two halves of the sleeve are put in place, surrounding the pipe, and bolted together. The joint between the sleeve and the pipe is then made exactly as would be done in the case of a solid sleeve, using either lead or cement. The latter is preferable, unless the conditions are very much against its use, since making lead joints involves the carrying to every repair job of a furnace, lead pot and ladle. Drawings of two styles of split sleeves, showing their dimensions and the number of bolts used can be found in the Proceedings of the American Gas Light Association, Vol. XV, page 88, and on page xiv of the Appendix, and also in the American Gas Light Journal, Vol. LXIX, page 712, and Progressive Age, Vol. XVI, page 529.

When the break runs too far along the pipe to be properly covered by a split sleeve, it is necessary to cut out the damaged portion of the pipe, making the cuts at least 3 or 4 inches beyond the furthest point reached by the crack at each end, and replace it by a new piece. To do this the main must be uncovered for a sufficient distance to enable bag holes of the proper size to be drilled and tapped far enough apart not to

interfere with the work of putting in the new piece. The gas having been shut off, by means of the bags inserted in these holes, the pipe is cut at the proper points, either with a pipe cutter or by the use of diamond point and cold chisels, and a new piece of pipe of the required length cut and put in, a solid sleeve being used to make the joint where the two spigot ends come together. Before sliding the sleeve into place, the opening between the two spigot ends is covered by wrapping the pipe with unbleached muslin prepared and used as is done in connection with the repair by means of a split sleeve. Either lead or cement joints can be made in the bell and in the sleeve, but the use of cement is generally preferable, for the reasons stated above. (Trustees.)

Fourth Series of Questions, 1902—Fifth Section—Practical Class—American Gas Light Association.

1. What conditions, other than the size, would determine your choice in selecting one of several kinds of anthracite coal offered for use as the generator fuel in a carburetted water gas apparatus.

2. How do you determine when the checker brick in a carburetted water gas apparatus needs cleaning?

3. Give a description, illustrated with sketches, of one or more forms of the condensers used for cooling illuminating gas during the process of manufacture.

4. Why is it important that all tar and oily matter should be removed from the gas before it enters the scrubbers and purifiers?

5. A two lift gas holder, the upper section of which is 150 feet in diameter, gives a pressure of 3 1/2 inches when uncupped, and one of 5 inches when cupped. What is the weight of each of the sections? Give your calculations.

6. A gas with a specific gravity of .670 is supplied to a building 65 feet high. The gas is at rest for the time. The pressure at the ground level, as shown by a syphon gauge, is

14/10 inches. What will be the pressure shown by a gauge attached to the riser pipe at the top of the building? Give your calculations.

7. In the answer to Question No. 7 of the Third Series for 1902 the yield of ammoniacal liquor per net ton of coal is given as 27 gallons of from 8 to 10 ounce strength. How many pounds of pure ammonia gas, NH_3, does this amount of liquor represent?

8. Describe—with sketch of a longitudinal section of both spigot and hub showing outside diameter of spigot, all dimensions of the hub or bell, the shape of the lead groove in the bell, and the depth and finished shape of the lead—the making of a lead joint in a 4-inch cast-iron main. Give also the amount of lead and packing used and the length of time that should be required to do the work.

9. What is a Holophane globe and how does it affect the useful light given by the source of light over which it is used?

10. In setting a gas range which has an oven burner and four top burners, what size of pipe should be used, and to what size meter should it be connected? Give the reasons for your answer.

11. Give a description, illustrated with sketches, of two or more methods of connecting services to street mains, and state what you consider to be the respective advantages and disadvantages of each method.

12. Describe the preparation and use of cement mortar for brick work construction, with the precautions to be observed to insure strength and uniformity.

(Answers to these questions are due Dec. 1, 1902.)

Answers to Fourth Series of Questions, 1902—Fifth Section—Practical Class—American Gas Light Association.

Answers to Questions Nos. 3, 9, 10 and 12 have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 3, Vol. XVIII, page 43.
No. 9, Vol. XVIII, page 54.
No. 10, Vol. XVIII, page 55.
No. 12, Vol. XV, page 24.

The answers to the other questions are as follows:

1. What conditions, other than the size, would determine your choice in selecting one of several kinds of anthracite coal offered for use as the generator fuel in a carburetted water gas apparatus?

Ans. The object sought in selecting an anthracite coal for use as the generator fuel in a carburetted water gas apparatus is to obtain the coal that will produce the most gas at the smallest cost. The price being equal, the cost of the gas is affected by the quantity of gas that can be made from a given weight of fuel, the amount of sulphur compounds in the gas, the rate at which the gas can be made and the amount of labor required to handle the apparatus. The quantity of gas that can be made depends largely upon the amount of fixed carbon in the coal and also upon the hardness and ability to withstand handling, and the weight of the fuel above it in the generator, without breaking up into small pieces. The amount of sulphur compounds in the gas depends, of course, upon the amount of sulphur in the coal, other things being equal. The rate at which gas can be made is influenced by the ability of the coal to resist crushing, without which the fire cannot be kept in good condition for gas making, as well as by the amount and character of the ash through its influence upon the nature and quantity of the clinker formed. This latter also determines the amount of labor required for cleaning the fire, while the cost of labor for gas making proper depends upon the rate at which the gas is made.

The best coal for the purpose named is therefore the one that contains the largest percentage of fixed carbon and is hard enough not to break up into small pieces in the generator, or while being handled before being put into the generator, and shows only small percentages of sulphur and of an ash that produces a clinker that does not unduly obstruct the passage of the blast and steam through the fire, nor make the cleaning of the fire difficult. To fulfill this condition the ash should not contain much sulphur or iron. Since a red color is due to the presence of iron, the white ash coals give the least trouble from clinker.

It is, however, difficult to secure a coal that possesses all of the above qualities in the highest degree, and also entirely possible to pay too much for them. Therefore, in making a choice between different kinds of coal, it is always necessary to balance advantages in one direction against disadvantages in another, and so determine carefully the relative values of the different samples, selecting the one that is shown in this way to be the cheapest at its price. (Trustees.)

2. How do you determine when the checker bricks in a carburetted water gas apparatus need cleaning?

Ans. The checker bricks of a carburetted water gas apparatus should be removed and cleaned, or renewed, when dirty or crushed, or disintegrated. Checker bricks may become covered with a non-conducting coating of ashes or carbon, or both, making impossible the desired exposure of the oil vapors to properly heated brick surfaces. When bricks are coated or saturated with carbon the surface heats rapidly, because the carbon burns, and the gas maker is deceived by the glowing carbon and believes the bricks to be hotter than they are. It is possible to tell something of the condition of the checker bricks by observation through the sight cocks provided for the purpose. Other indications of dirty bricks are a falling off in the rate of make per minute and in the oil results. If all the conditions of operating remain unchanged, and the candle power falls materially and stays down and the make of gas per minute of run is reduced, the checker bricks should be at once examined and, if dirty, removed and cleaned. Bricks should

not be allowed to become so fouled as to make a material reduction in the rate of make. Experience soon teaches an intelligent gas maker to avoid both the extreme of reduced results and of too frequent cleaning.

It is the custom in many works, especially those that are provided with a spare set of apparatus, to change the checker bricks at regular intervals, these intervals being measured in some cases by the number of days that the set has been in operation, and in others by the number of hours of work actually done. The object of changing the bricks at fixed intervals in this way is to avoid the irregularities in make and working results that arise from running until it is absolutely necessary to make the change, it being thought that the loss due to a day or two of poor working is greater than the slight extra cost involved in cleaning the bricks a little oftener.

In a works that has only one set of apparatus, the bricks should be put in good shape as late as possible in the Fall so that they will be in good condition during the heavy make of December and January. (Trustees.)

4. Why is it important that all tar and oily matter should be removed from the gas before it enters the scrubbers and purifiers?

Ans. If the tar and oily matter are not removed from the gas before it enters the scrubbers in a coal gas works, they will coat the material in these vessels with a greasy film, that will prevent the water from being spread out and presented to the gas in thin sheets covering the whole surface of the material and will thus render the contact between water and gas imperfect, with a consequent reduction in the efficiency of the apparatus. If the scrubbers are filled with coke, the deposition of the tar will also fill up the pores of the coke and the spaces between the different lumps, and by thus closing up the channels through which the gas has to pass, will cause the scrubbers to throw a high pressure and make it necessary to remove the coke much oftener than would otherwise be the case, increasing in this way quite considerably the cost of material and handling.

The presence of tar and oily matter in the gas produces a

similar effect in the purifiers. The friction to which the gas is subjected in passing through the purifying material causes the tar and oil to be deposited, coating the different particles of the material with a film that prevents any contact between them and the gas, and thus renders them incapable of doing any of the work of purification. If either tar or oil is present in sufficient quantity, its deposition makes the material at the bottom of the first purifier moist and soggy, and when in this state it is very difficult for the gas to pass through it, so that it is often necessary to change the purifiers before they are foul on account of excessive pressure. This further increases the cost of labor in addition to the increase in cost of both labor and material caused by the material being rendered inefficient. In the case of iron-oxide the oily film on the particles prevents revivification as well as purification, the material lying next to the bottom trays being made unfit for further use, the effect extending to a greater or less distance from the bottom according to the amount of tar and oil in the gas.

In addition to the main effects noted above, the coating of the scrubbing and purifying materials with a film of tar and oil, by causing intimate contact between tar and gas, also reduces the candle power of the gas to a slight extent. (Trustees.)

5. A two-lift gas holder, the upper section of which is 150 feet in diameter, gives a pressure of 3½ inches when uncupped, and one of 5 inches when cupped. What is the weight of each of the sections? Give your calculations.

Ans. The pressure thrown by a gas holder, as measured in inches of water by a syphon gauge, is the height, in inches, of the column of water that is balanced by the weight of the holder. As the pressure acts on each unit of area of the holder crown, the weight of the holder is equal to the product obtained by multiplying the area of its crown by the weight of a column of water, having a height equal to the pressure thrown by the holder and an area equal to the unit used in expressing the area of the crown. Each inch of pressure will represent a weight of 5.208 pounds per square foot, or 0.036

pound per square inch, since a cubic foot of water weighs 62.5 pounds and therefore a column of water one square foot in area and one inch high will weigh $\frac{62.5}{12} = 5.208$ pounds, and a column of water one square inch in area and one inch high will weigh $\frac{62.5}{1728} = 0.036$ pound.

In the example given, the holder has a diameter of 150 feet. The area of a circle being equal to the square of its diameter multiplied by 0.7854, the area of the crown is $150' \times 150' \times 0.7854 = 17671.46$ square feet. The pressure thrown when the holder is uncupped, that is, when the upper or inner section alone is working, is $3\frac{1}{2}''$. The weight of this section is therefore $17671.46 \times 5.208 \times 3.5 = 17671.46 \times 18.228 = 322,115$ pounds.

In the same way the weight of the two sections together is equal to $17671.46 \times 5.208 \times 5 = 17671.46 \times 26.040 = 460,164$ pounds.

The weight of the outer section will be $460,164 - 323,115 = 138,049$ pounds.

In the Handbooks for Gas Engineers, tables are given showing the weights in pounds corresponding to each $1/10''$ of pressure thrown by gas holders of different diameters from 20 feet to 150 feet. The weight of any given holder can be obtained by multiplying the number found opposite the diameter of the holder in these tables by the pressure thrown expressed in tenths of an inch. The figure given in the table for a holder 150 feet in diameter is 9,205, and this multiplied by 35 and 50, gives 322,175 pounds and 460,250 pounds as the respective weights of the upper section alone and of both sections combined. The difference between the weights obtained by the two methods is probably due to a greater number of decimal places having been used in making the calculations by which the tabular numbers are obtained than were used in the calculations given in the first part of this answer. (Trustees.)

6. A gas with a specific gravity of .670 is supplied to a building 65 feet high. The gas is at rest for the time. The pressure at the ground level, as shown by a syphon gauge, is 14/10 inches. What will be the pressure shown by a gauge

attached to the riser pipe at the top of the building? Give your calculations.

Ans. From the answer to Question No. 6 of the Third Series for 1902, we find that the amount of the difference in gauge pressure between the upper and lower ends of a vertical gas pipe can be obtained by dividing the difference between the weight of a column of air with an area of one square inch and a height equal to the difference in elevation between the two ends of the pipe and that of a column of gas of the same area and height, by the weight of a cubic inch of water.

In this case the difference in elevation between the ends of the pipe is 65′ and the specific gravity is given as .67. A column of air one square inch in area and 65′ high will contain $65 \times 12 \times 1 = 780$ cubic inches, and since the weight of a cubic inch of air is .00004418 pound, the weight of this column will be $780 \times .00004418 = .0345$ pound. Since the gas has a specific gravity of .67, the weight of a column of gas will be .67 times the weight of the column of air, and the difference between the weight of the column of air and that of the gas will be .33 times the weight of the column of air.

This difference will therefore be $.0345 \times 33 = .011385$ pound. The weight of a cubic inch of water is .036 pound, and the increase in pressure will be $.011385 \div .036 = .32''$, and the pressure at the top of the pipe will be equal to the pressure at the bottom plus this difference, or to 14/10 plus $3/10 = 17/10''$. (Trustees.)

7. In the answer to Question No. 7 of the Third Series for 1902, the yield of ammoniacal liquor per net ton of coal is given as 27 gallons of from 8 to 10 ounce strength. How many pounds of pure ammonia gas, NH_3, does this amount of liquor represent?

Ans. Since the term ounce as used in designating the strength of ammoniacal liquor means that a gallon of the liquor contains, for each ounce strength, the quantity of pure ammonia that will neutralize one ounce of pure monohydrated sulphuric acid (H_2SO_4) with a specific gravity of 1.84, each gallon of 8 to 10 ounce liquor will contain an amount of ammonia that will neutralize 8 to 10 ounces of sulphuric acid.

The reaction between ammonia (NH_3) and sulphuric acid (H_2SO_4) takes place according to the following equation, $2NH_3 + H_2SO_4 = (NH_4)_2\ SO_4$. The proportions by weight in which substances combine with each other can be determined from the molecular weights shown by the equation to enter into the reaction according to which the combination takes place. As the atomic weight of Nitrogen (N) is 14, that of Hydrogen (H) 1, that of Sulphur (S) 32 and that of Oxygen (O) 16, the proportion by weight in which ammonia and sulphuric acid combine will be $2\ (14 + 3) = 34$ parts of ammonia and $(2 \times 1) + 32 + (16 \times 4) = 2 + 32 + 64 = 98$ parts of sulphuric acid. One ounce of the latter will therefore combine with $\frac{34}{98} = 0.3469$ ounce of the former and ammoniacal liquor will contain 0.3469 ounce of ammonia per gallon for each ounce of its strength. Or, in other words, the number of ounces of ammonia contained in a given number of gallons of ammoniacal liquor of a given strength is equal to the continued product of the number of gallons, the strength in ounces and 0.3469.

27 gallons of 8 ounce liquor will therefore contain $27 \times 8 \times 0.3469 = 216 \times 0.3469 = 74.93$ ounces or 4.68 pounds of ammonia, while 27 gallons of 10 ounce liquor will contain $27 \times 10 \times 0.3469 = 270 \times 0.3469 = 93.66$ ounces or 5.85 pounds. (Trustees.)

8. Describe—with sketch of a longitudinal section of both spigot and hub showing outside diameter of spigot, all dimensions of the hub or bell, the shape of the lead groove in the bell and the depth and finished shape of the lead—the making of a lead joint in a 4-inch cast iron main. Give also the amount of lead and packing used and the length of time that should be required to do the work.

Ans. In making a lead joint in a 4″ cast iron main, the first step in the operation, after the spigot end of one length has been inserted in the bell of the other and the length driven home, lined up and fixed in place by the tamping of a little dirt around the middle of it, is to fill solidly with packing, a portion of the joint space between the spigot and bell, the amount of space so filled being determined by the depth of

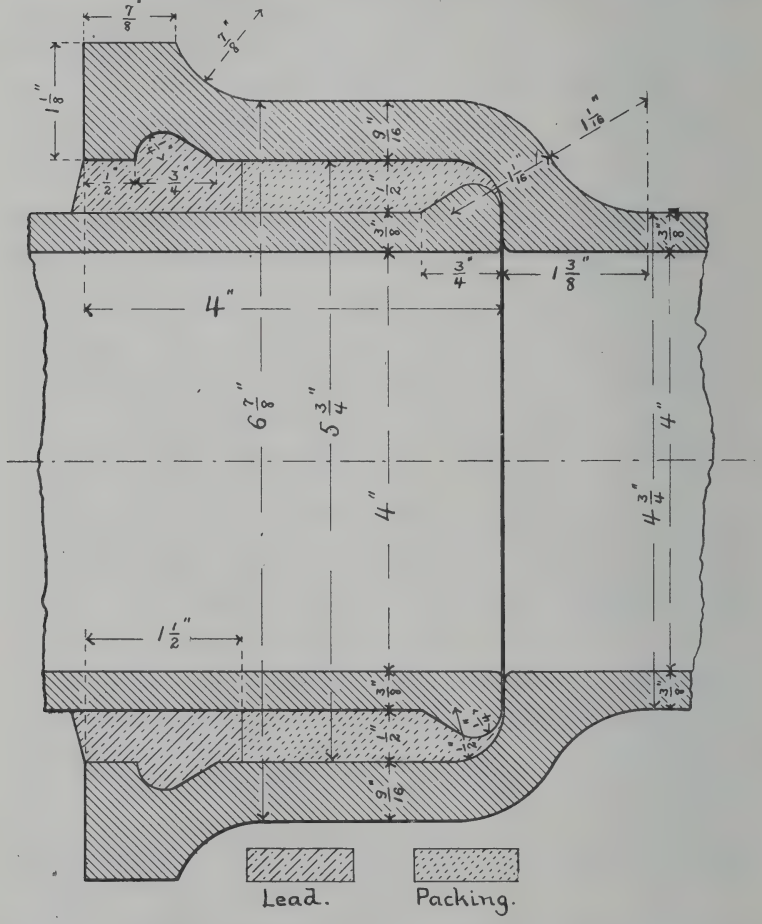
lead which it is desired to have. For ordinary straight work with 4″ pipe, the depth of lead may be taken at 1½″, and the joint space will therefore be filled with packing to a point 1½″ back from the face of the bell.

Jute packing, either plain or tarred, is usually employed. Packing which has been allowed to absorb a small quantity of tar can be driven tighter than plain packing, but tar being cheaper than jute it is hard to obtain tarred packing without more than the proper amount of tar, and for this reason plain packing is often given the preference.

A sufficient number of strands of packing should be twisted to form a rope of a diameter a trifle larger than the width of the joint space, and this should be cut into pieces of such length that the ends will come into close contact when a piece is placed around the outside of the spigot end of the pipe and pulled up tight. One of these pieces is used to lift the spigot end as it is inserted into the bell of the pipe previously laid, and is sent home with it, thus keeping the spigot central in the bell and avoiding the necessity of wedging it up after it is in place. This piece of packing is driven solidly into place in the bottom of the joint space by means of a caulking hammer and packing iron, and other pieces are inserted one at a time, the joint in each ring being put say one-fourth of the circumference away from the joint in the preceding ring, and each driven home, a sufficient number being used to fill the joint space to the required depth, leaving 1½″ for the lead. The packing must be driven hard and the finished layer must be of uniform depth so that the lead space will be uniform all around the pipe.

A clay roll or other form of joint runner is then placed around the spigot end of the pipe, being brought tight against the face of the bell, and so set as to leave a triangular space, having its base on the pipe and its apex on the face of the bell slightly above the inside edge, which the lead can fill and thus make it certain that when driven the joint will be of the shape shown on the cut. Molten lead is run into the joint and this space until both are completely filled and the lead stands above the highest point on the inside edge of the bell, the lead being poured in through an opening, or "gate" left on top of the

pipe. When the lead has hardened, the joint runner is removed and the "gate," or lump of lead where the opening for pouring was made, is cut off. The lead is then chiseled all around the pipe with a cold chisel and caulking hammer. This



Section of 4 in. Bell, Spigot and Lead Joint.

American Gas Light Associciation Standard.

separates the lead from the surface of the pipe and makes a groove in which the first caulking tool, the face of which is about 3/16″ thick, can fit. The lead is driven all around with

this tool, and then with tools successively increasing in thickness about 1/8″ until the full width of the joint has been reached. The work with each tool should be begun at the bottom of the pipe and carried around each way, finishing up at the top. The thickness of the last tool used should not be greater than the width of the joint, and the driving with this tool should cut the lead off sharp with the inside edge of the bell, otherwise there is danger that the force of the blows will be expended against the face of the bell instead of doing the full amount of work that it should do in compressing the lead in the joint. In order to have the tools fit the joints exactly it is well to have them made in sizes varying in thickness 1/16″, though it is only necessary to use on any joint tools varying by 1/8″, the proper sizes being selected. The position in which the tools are naturally held when caulking the joint will give it the finished shape shown on the cut, if the joint runner has been put on properly and sufficient lead used.

There will be required for making a 4″ lead joint about 4 to 5 pounds of lead, and 7 to 9 oz. of jute packing, unavoidable waste being included in each case. A good workman should be able to average nearly 5 joints an hour for a day's work.

The cut shows the spigot and bell of the standard dimensions adopted by the American Gas Light Association in 1898. (Trustees.)

11. Give a description, illustrated with sketches, of two or more methods of connecting services to street mains, and state what you consider to be the respective advantages and disadvantages of each method.

Ans. Figure 1 shows the swing joint connection and is the method now most widely used. It is the joint between the street tee and the street ell that gives the connection its name and enables the direction of the service pipe to be changed at will during laying, without throwing any strain on the main. This flexibility of service line is especially valuable in congested city streets, where a service has at times but a contracted passage, over some obstructions and under others; or where for any reason two parts of a service are joined by a long screw. Not only does the swing joint enable the laying of a

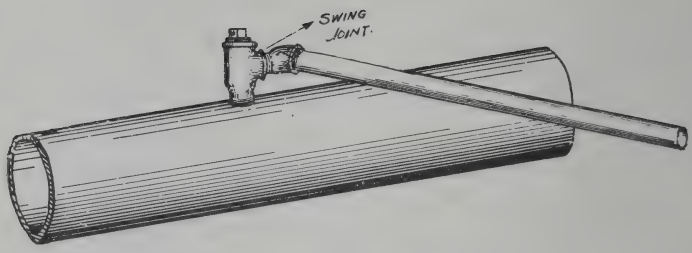


FIG. 1.

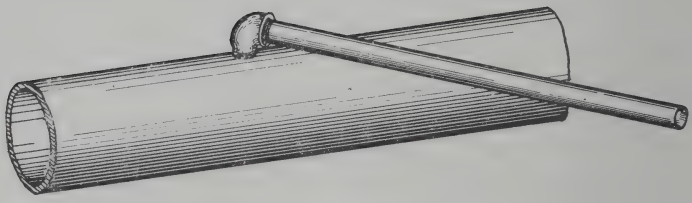


FIG. 2.

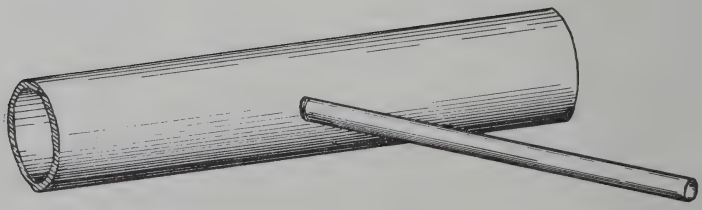


FIG. 3.

service without any strain being left on the main, but also should, at any future time, pressure bear down on the service, the joint would be of use in either wholly or in great part taking up the strain.

There are a few engineers who believe that where, as in most large cities, a service seldom rests on undisturbed earth, it is safer to block the pipe at each socket, on both sides of the cock and also close to the main. Of course, this blocking at the main prevents the swing joint from being of use to take up strains coming on the service after it is laid ; but the advocates of the blocking believe that a blocked service cannot be pressed down to such an extent as to bring a severe strain on the main, and they desire the blocking under the service at the main, in order to prevent any strain that may come in the direction of the length of the main, due to the fact that the line of the service is offset from the tap hole by the distance from centre of tee to centre of ell.

The use of the tee instead of an ell enables the flow of gas to be stopped while the service is being laid (a tapered rubber plug being made for this purpose), and in case of any stoppage in a service requiring digging at the main, the access to the service through the top of the tee may obviate any necessity for cutting the service.

The only objection that can be advanced against this form of connection is the greater liability to stoppages as compared with the stiff top connection shown in Figure 2 and the straight side connection shown in Figure 3, Figure 1 having one more bend than Figure 2, and two more than Figure 3. This objection has no force applied to the large present day services and the well-purified gas now being sent out, as the cause of the stoppages found in service bends is almost invariably due to rust and sulphur compounds bridging over the comparatively small bore of a ½″ or ¾″ pipe. Even naphthalene need not be considered, for it never appears in this country at the junction of main and service.

Figure 2 shows the rigid form of top connections, and many thousands of services have been laid in this manner. As has just been said in talking of the swing joint connection, the advantages of simplicity possessed by Figure 2 over Figure 1

are outweighed by the disadvantage of the rigidity of connection, a rigidity which has been the cause of many breaks in 2″, 3″ and 4″ mains.

Figure 3, the straight connection into the side of the main, is the oldest of all forms of connection, and was formerly used to a large extent. It allows a wire to be passed through the service into the main itself, quite an advantage when service stoppages were frequent. At present, this advantage of a straight line from house to main is of small importance, while aside from the rigid connection to the main possessed in common by Figure 3 with Figure 2, the growing congestion of city streets makes a side tapped hole more and more an impossibility, because of lack of room to work either a tapping machine or a chisel in a horizontal position. (Trustees.)

Fourth Series of Questions, 1902—Fourth Section—Practical Class—American Gas Light Association.

1. In making coal gas what influence has the relation between the volume of the charge of coal and the volume of the retort upon the quality of the gas produced from the coal?

2. Describe the operation of a bench of coal gas retorts heated by a regenerative bench, either half depth or full depth, including the care and operation of the furnace, stand-pipes and hydraulic main.

3. Give a description, illustrated by sketches, of the construction and operation of one or more forms of governor for regulating the speed of a coal gas exhauster so as to maintain a uniform pressure, or vacuum, on the hydraulic main.

4. What points are to be provided for in designing the stand-pipes, bridge pipes and dip pipes for a bench of coal gas retorts?

5. How much heat is required to change a pound of water at a temperature of 100° F. into steam at a gauge pressure of 70 lbs.?

6. How would you prepare lime for use in purifying gas?

7. What is the influence of heat upon the chemical reactions that occur in the purifiers, and what bearing does this influence have upon the question of the heating of purifying houses, lime rooms and revivifying rooms?

8. A cylindrical oil tank, placed with its axis horizontal, is 4′ 0″ in diameter and 20′ 0″ long. How would you determine the amount of oil it holds for every inch in depth of the oil from 1″ to 48″?

9. A calorimeter test made on a certain illuminating gas gave the following data: Gas consumed, 0.10 cubic feet; average temperature of water entering the calorimeter, 2.4° C.; average temperature of water leaving the calorimeter, 15.3° C.; quantity of water collected, 1505 c. c. (cubic centimetres); quantity of condensed water, 27 c. c. per cubic foot of gas; temperature of gas at meter, 46.5° F.; height of barometer, 29.33″. Calculate both the gross and the net calorific value of the gas.

10. It is desired to deliver 9,500 cubic feet of gas per hour through a pipe one mile long with a loss of pressure of 0.5″. The specific gravity of the gas is .55. What size pipe will be required? Give your calculations.

11. Give a description, illustrated by sketches, of some form of instantaneous gas water-heater.

12. State some of the reasons for the increasing use of Portland cement concrete in the place of brick or stone masonry.

(Answers to these questions are due January 15, 1903.)

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Answers to Fourth Series of Questions, 1902—Fourth Section—Practical Class—American Gas Light Association.

Answers to Questions Nos. 6 and 7 have been published in previous volumes of the Proceedings and can be found there as follows:

No. 6, Vol. XIV, page 19.

No. 7, Vol. XVI, page 83.

The answers to the other questions are as follows:

1. In making coal gas what influence has the relation between the volume of the charge of coal and the volume of the retort upon the quality of the gas produced from the coal?

Ans. The relation between the volume of the charge of coal and the volume of the retort, or, as it is sometimes expressed, the relation between the area of the cross section of the charge and that of the cross section of the retort, has a very decided influence upon the quality of the gas produced and also upon the amount of trouble experienced from stoppages in the stand-pipes and thickening of the tar in the hydraulic main. The quality of the gas is at its best, other things being equal, and the least trouble is experienced, when the volume of the charge is such as to almost completely fill the retort.

The reason for this can readily be seen when the effects produced upon the coal and gas by the exposure to heat to which they are subjected are considered. When the charge is first put into the retort the temperature of the coal, and of the portion of the surface of the retort covered by the coal, is low and the products of distillation are hydrocarbons of high boiling points, that exist as vapors at the temperature in the retort, but condense to liquids when cooled to atmospheric temperatures. As the charge becomes heated, however, hydrocarbons of lower boiling points are given off which will remain in the state of gas or vapor at atmospheric temperatures. The interior surface of the retort has by this time again reached its original high temperature, and as the hydrocarbons evolved from the coal pass, on their way to the stand-pipe, through the space left above the charge, they are exposed both to contact with this hot surface and to the heat radiated from it. The effect of this exposure is to break up the more complex hydrocarbons and form hydrogen, simpler hydrocarbons, and free carbon, and given a temperature sufficiently high and an exposure of sufficient length the final result would be the formation of a gas consisting of hydrogen and marsh gas with no higher hydrocarbons, and the setting free of a large amount of carbon. Such a gas would be non-luminous, so that, although a certain amount of this breaking up of the higher hydrocarbons after they are evolved from the coal is required to produce a per-

manent gas, especially at the beginning of the distillation, it is important that the operation should not be carried too far.

The length of time during which the gas will be exposed to this heat depends upon the velocity with which it travels, and this velocity in turn depends upon the area of the part of the cross section of the retort that is not taken up by the charge and upon the rate at which gas is being made. An increase in the volume of the charge for a given size of retort will, therefore, increase the velocity with which the gas passes to the stand-pipes, first, by reducing the area of the space through which it passes, and, second, by increasing the rate at which the gas is made, the combined result being that the gas remains exposed to the action of the heated surface of the retort for a much shorter time, and is therefore much less affected by this exposure.

It is true that, although the gas is less exposed to radiant heat when the space is small and the velocity great, a larger percentage of it is brought into actual contact with the surface of the retort, owing to the increase in the ratio between the perimeter and the area of a polygon that occurs when the area is reduced, and that it is also exposed to contact with a greater amount of heated surface as it escapes from the interior of the charge. But experience shows that the combined effect of the radiant heat and the contact with the heated surface in the space above the charge is less harmful when the space is small, and contact with the heated portion of the charge does not have as much effect as contact with the surface of the retort, since during the period in which the greatest amount of gas is given off the temperature of the charge is much lower than that of the retort walls, as, during the first two hours, the temperature of the charge does not exceed 1200° F., while that of the interior surface of the roof of the retort is, in regenerative benches, about 2000° F.

It is therefore important that the size of the retort should be so chosen that the charge which can be carbonized in the desired length of time with the heat to be carried, will fill the retort as full as it is possible to have it and still leave room for the operation of the drawing and charging tools. (Trustees.)

2. Describe the operation of a bench of coal gas retorts heated by a regenerative furnace, either half depth or full depth, including the care and operation of the furnace, standpipes and hydraulic main.

Ans. The first point to be noted in operating a regenerative bench is the regulation of the draft. The chimney dampers should be pushed in until on opening the charging door of the furnace and throwing into the fire a handful of coal dust, the resulting flame plays lazily back and forth out of the door, neither being drawn steadily in by the draft, nor burning up vigorously. The dampers set, the heat is regulated by increasing or decreasing the primary air opening, the secondary air being kept properly proportioned to the amount of carbonic oxide produced by the furnace. The chimney dampers will need readjustment if the quantity of fuel consumed varies materially.

The proper amount of secondary air opening is determined by noting the disappearance in the take-off flue, or at any convenient point of observation in the waste gas flues of the recuperators, where the heat is not too high, of the blue flame that indicates the escape of unconsumed carbonic oxide from the combustion chamber. If this flame is present the secondary air opening is gradually increased until the flame disappears, waiting a sufficient length of time after each slight increase of opening for the additional air to travel through the bench. When the flame is gone the adjustment is right and the secondary air slides should be clamped. If no flame is present and the adjustment has not been made for some time, the secondary air openings are decreased until the flame appears, and then the adjustment made as above. The quantity of carbonic oxide produced varying with the condition of the fire as to the amount of ashes, depth of fuel-bed, etc., the secondary air supply cannot be kept exactly right for every hour of the day; and this being so, enough is supplied to consume the average maximum production of carbonic oxide, since the loss of heat due to the small excess of secondary air present when less carbonic oxide is made, is smaller than would be suffered by allowing an equal quantity of carbonic

oxide to escape unconsumed ; the loss of sensible heat being practically equal in both cases, while with the unconsumed carbonic oxide there is the additional loss of its heat-producing power.

After this adjustment of the damper and air slides is made, they are fastened so securely that it is impossible for them to be moved unintentionally.

It is necessary for the proper working of a generator furnace that the fuel-bed be kept deep, and the depth be uniform throughout the furnace.

In cleaning the fire there should be no work done from the top of the furnace, allowing a rush of cold air through the bench. All the work is done through the cleaning door with a good bed of fuel left in the furnace to heat the excess of inflowing air. Secondary bars, resting on supports provided for the purpose, are driven in above the clinker line to hold up the fire ; the grate bars are drawn, dropping the ashes into the pan ; any hard clinker on the walls is cut away with chisel bars, the grate bars are replaced and the secondary bars withdrawn, thus letting the fire down upon the grate again.

After taking out the ashes dropped into the pan during the cleaning of the fire, the dirt that has worked into the primary air openings should be raked out.

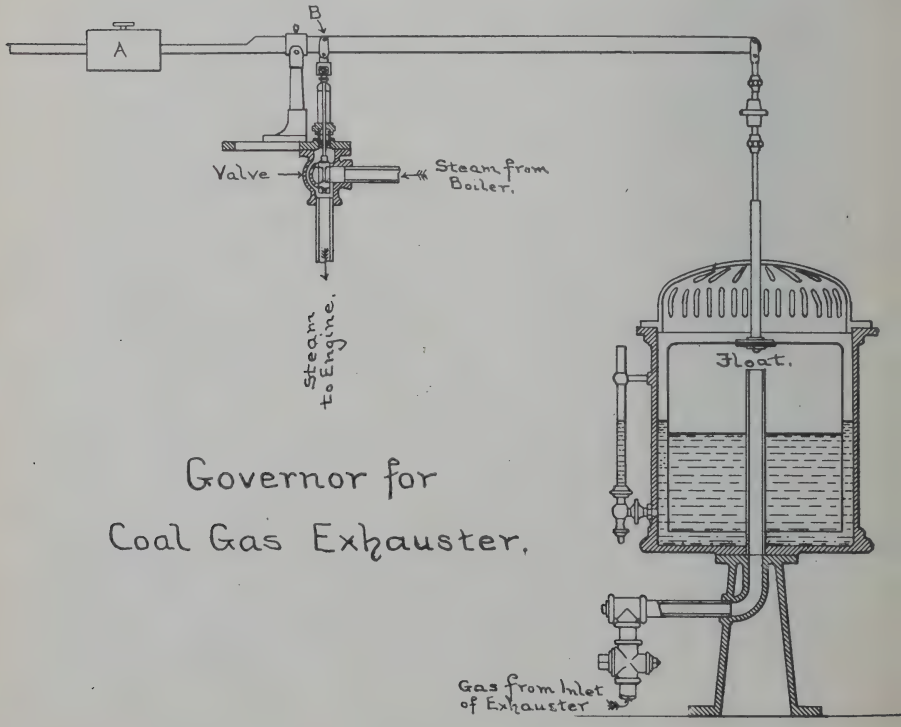
Every six weeks, or two months, the recuperator flues should be cleaned of the deposit of flue dust, as this interferes with the free transmission of heat through the walls to the secondary air. The primary air flues also need regular attention, the bursts of steam caused by the dropping of hot ashes and clinker into the water in the ash pan, when the fire is cleaned, carrying fine dust back into these flues beyond reach from the furnace.

Passing now to the care of the stand-pipes, these should be kept clean. The portion near the mouthpiece should be thoroughly cleaned each time the retort is drawn, and if choked so that the auger cannot be forced up at this time, should be augered after the charge has been in about an hour, when the obstruction will have been softened. The whole pipe should be cleaned every time the retort is scurfed, so as to allow the passage of a test ring $\frac{1}{4}''$ less in diameter than

the pipe. The same course should be followed if the pipe stops up from any cause, the retort never being put back into action until a ring as above will pass down the full length of the pipe.

Unless means for removing the tar as it forms are provided, it should be run off the hydraulic main at least twice in every twenty-four hours, and more often in case the main is small, to avoid any possibility of the dip pipes being sealed in tar. In case the tar becomes too thick to run through the take-off, it must be cleaned out through the cleaning holes with which the main should be provided. While running the tar off care must be taken to maintain the seal of the dip pipes. Ordinarily the seal is maintained by the liquor condensed from the gas, and a suitable overflow must be provided, at the right height, to carry off this liquor. (Trustees.)

3. Give a description, illustrated by sketches, of the construction and operation of one or more forms of governor for



Governor for Coal Gas Exhauster.

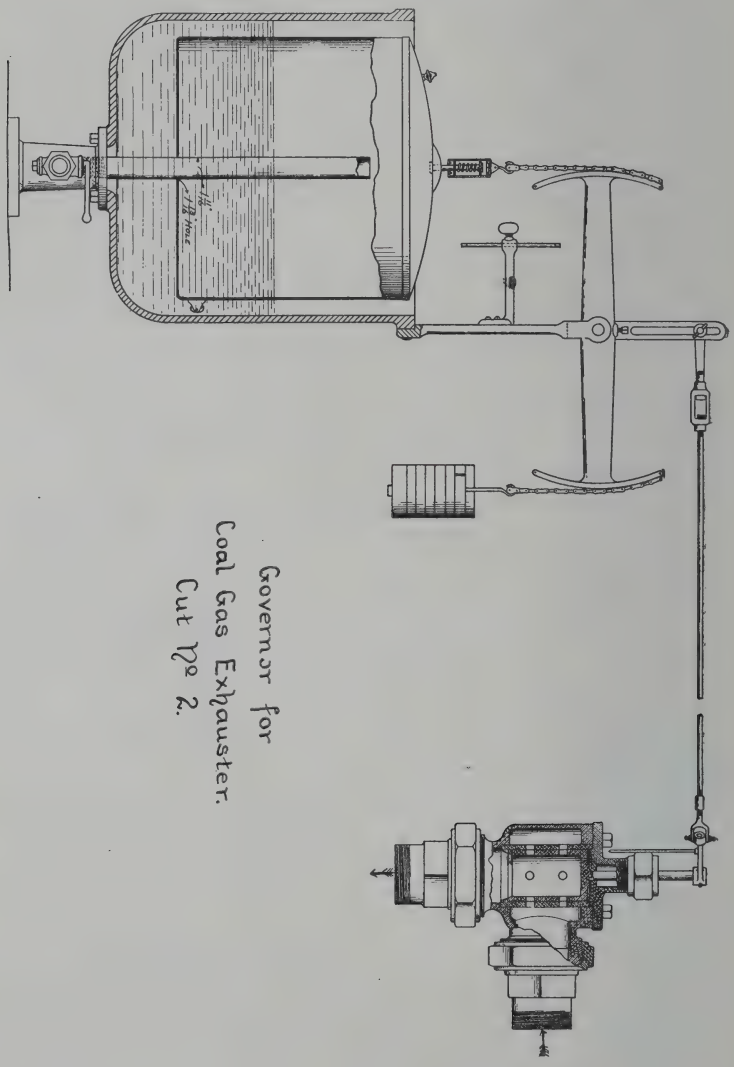
regulating the speed of a coal gas exhauster so as to maintain a uniform pressure, or vacuum, on the hydraulic main.

Ans. One form of such governor is shown in the cut. The inlet of the exhauster is connected by a pipe, as shown, with the interior of a small holder or float, which is free to rise or fall in a vessel of water. This float is connected to a lever, as shown, and is balanced by a weight A on the end of the lever. At point B, attachment is made to a valve on the steam pipe from the boiler to the engine, the whole being so arranged that as the float rises the valve is opened, admitting more steam to the engine, and as the float falls, the valve is closed, reducing the amount of steam fed to the engine. If the make of gas increases, the pressure in the apparatus between the retort and the exhauster is increased, the pressure under the float is increased, and it rises, opening the steam valve and increasing the speed of the engine. The speed of the exhauster is thus increased, and the pressure at the inlet of the exhauster reduced to normal.

On cut No. 2 is shown another form of exhauster governor embodying exactly the same principles in a slightly different form of apparatus. In this case a rotary, instead of a lifting, valve is used to regulate the amount of steam admitted to the engine and the up and down motion of the bell is transmitted to the valve, and changed into a horizontal rotary motion by means of a rocker arm and system of levers as shown on the cut. Otherwise the action of the governor is exactly the same as that of the one described above.

In order to obtain with these governors the close regulation of the vacuum, maintaining it between limits only two or three tenths of an inch of water apart, it is necessary that everything about them shall work freely and that there shall be no binding at any point. All bearings and places where there is any movement of one surface upon another must be kept well lubricated and must not be allowed to become gummed up. It is also necessary to restrict the rapidity of motion of the bell so that it will not move so rapidly as to carry beyond the desired point and thus keep the vacuum oscillating violently back and forth and so defeat its own object. This is done in

the governor first described by having the stop cock on the pipe connecting the interior of the bell with the inlet to the exhauster, open only a very small amount so that gas can



Governor for
Coal Gas Exhauster.
Cut Nº 2.

pass in or out at only a slow rate as the bell rises or falls. Small V-shaped grooves, filed one on each side of the hole through the plug of the stop cock, give openings with which

the best results are obtained, the plug being set in such a position that the grooves alone come opposite the openings in the barrel, the main opening in the plug being entirely shut off except for the grooves. In the governor shown on cut No. 2 the same result is sought by making the bell with a closed bottom, as shown, and having the opening in this bottom, through which the pressure pipe passes into the bell, only a very little larger than the pipe. As the bell rises or falls, the water driven out, or drawn in, can pass through this opening only very slowly, and consequently the bell can move at a slow speed only. (Trustees.)

4. What points are to be provided for in designing the stand-pipes, bridge pipes and dip pipes for a bench of coal-gas retorts?

Ans. The most important thing to be provided for in designing the stand-pipes, bridge pipes and dip pipes for a bench of coal-gas retorts is that they shall be made so that every point in each of them can be reached with a cleaning tool having a diameter not more than 1/2″ smaller than that of the pipe. To enable this to be done the bent pipes must be made with very gradual curves and without any abrupt changes of direction, and the dip pipes should be made perfectly straight from the cleaning opening on top to the lower end dipping under the water in the hydraulic main. If abrupt curves are used it will be impossible to keep the pipes clear and free from stoppages.

It is also well to keep the number of joints down to a minimum, as the breaks in the surface at joints afford an opportunity for the building up of obstructions.

If the above points are observed, the necessity of having the pipes of large diameter is not as great as it is sometimes thought to be, pipes 7″ in diameter being amply large for retorts carbonizing 350 pounds of coal in four hours.

It is understood to be a matter of course that the pipes will be provided with flanged joints, to enable them to be easily removed and replaced when necessary, and with proper cleaning openings, while the question of whether cast iron or wrought iron is to be used for the stand-pipes is such an open one that it will not be taken up here. (Trustees.)

5. How much heat is required to change a pound of water at a temperature of 100° F. into steam at a gauge pressure of 70 pounds?

Ans. The amount of heat required to change a pound of water at a temperature of 100° F. into steam at a gauge pressure of 70 pounds is equal to the total amount of heat in a pound of steam at 70 pounds pressure less the amount of heat in a pound of water at a temperature of 100 F°. The total amount of heat required to raise the temperature of a pound of water from 32° to that of the boiling point at any pressure and then convert it into saturated steam can be determined from the formula $H = 1081.4 + 0.305t$, in which H is the number of B. T. U. (British thermal units) required, and t is the common temperature of the water and steam in degrees Fahrenheit. The temperature corresponding to any given pressure can be calculated from the formula $t = \frac{2938.16}{6.1993544 - \log p} - 371.85$, in which p is the absolute pressure in pounds per square inch and t is the temperature in degrees Fahrenheit.

In the problem set in the question, the gauge pressure at which the steam is formed being 70 pounds the absolute pressure is 84.7 pounds and $t = \frac{2938.16}{6.1993544 - \log 84.7} - 371.85$ $= \frac{2938.16}{6.1993544 - 1.9278834} - 371.85 = \frac{2938.16}{4.271471} - 371.85 =$ $687.85 - 371.85 = 316°$ F. Substituting this value in the formula for the total heat we have $H = 1081.4 + 0.305 \times 316$ $= 1081.4 + 96.38 = 1177.78$ B. T. U.

The amount of heat required to raise the temperature of a pound of water from 32° F. to 100° F. can, unless extreme accuracy is necessary, be taken as being equal to 68 B. T. U., that is, one B. T. U. for each degree difference in temperature.

The heat required to convert a pound of water at a temperature of 100° F. into steam at a gauge pressure of 70 pounds will therefore be $1177.78 - 68 = 1109.78$ B. T. U.

Tables have been made out giving the quantity of heat in a pound of steam for absolute pressures from 0.5 to 400 pounds per square inch, and are published in almost every book treating of the properties of steam. If copies of these

tables are available the value of H need not be calculated, but can be obtained from them in the following manner: As the pressure in the present problem is 84.7 the corresponding value for H will be less than that for 85 pounds by an amount equal to the product obtained by multiplying the difference between the values for 84 and 85 pounds respectively by 0.3. The value for 84 pounds absolute pressure is given as 1177.6 and that for 85 pounds as 1177.9 B. T. U. The difference between them is 0.3 B. T. U. Hence, the value for 84.7 pounds equals $1177.9 - (0.3 \times 0.3) = 1177.9 - 0.09 = 1177.81$. Subtracting 68 from this, as before, gives the heat required to convert a pound of water at a temperature of 100° F. into steam at a gauge pressure of 70 pounds, which will therefore be $1177.81 - 68 = 1109.81$ B. T. U. The difference between the result as calculated and that obtained from the tables is due to the difference in the number of decimal places employed in the two cases. (Trustees.)

8. A cylindrical oil tank, placed with its axis horizontal, is 4′ 0″ in diameter and 20′ 0″ long. How would you determine the amount of oil it holds for every inch in depth of the oil from 1″ to 48″?

Ans. The simplest method of determining the amount of oil contained in a cylindrical oil tank set with its axis horizontal, when the tank is filled to certain levels, is a graphical one. On a piece of paper spread on a drawing-board or a smooth floor, draw a semicircle with a radius equal to that of the tank. Draw a line passing through the centre and stopping at each end of the circumference, or, in other words, draw a diameter of the circle. Then draw lines parallel to this diameter and 1″ apart until the whole semicircle has been divided into strips 1″ wide. The area is now divided into a number of quadrilaterals, which are practically trapezoids, since the portion of the circumference included between adjacent lines is practically a straight line; with a segment of the circle at the bottom. An isosceles triangle, equivalent in area to this segment, can be formed by erecting a perpendicular at the middle point of the lowest one of the parallel lines, and from a point on this perpendicular a little outside of the cir-

cumference of the circle, drawing a line on each side down to the base at the proper inclination to make it cut the circumference of the circle at such a point that the area included between the line, the circumference and the perpendicular and lying outside of the circumference, is equal to the area included between the line, the circumference and the lowest of the parallel lines and lying inside of the circumference. A very close equality between these areas can be secured by eye after one or two trials. If the tank is a small one and the curvature of the circumference sharp, it may be necessary to draw the parallel lines only ½″ apart in order not to have the portion of the circumference between two adjacent lines deviate too much from a straight line, and in the present case it is necessary to do this for the lower 10″ of the semicircle, the whole being thus divided into fourteen 1″ strips, nineteen ½″ strips and a segment having a height of ½″.

The semicircle having been divided up in this way, the calculations are very simple. Starting with the triangle, measure the lengths of its base and its altitude in inches, and multiply the base by one-half the altitude. The product is the area of the triangle in square inches. Multiply this by the length of the tank in inches and the product is the volume in cubic inches of the space inclosed between the bottom of the tank and a plane parallel to the axis of the cylinder, and passing through a horizontal line drawn 1″ above the lowest point in the circumference. Divide this volume by 231 (the number of cubic inches in a gallon) and the quotient is the number of gallons in the tank when the liquid in it is 1″ high. Having determined this, the next step is to obtain the area of the trapezoid immediately above the triangle. To do this, measure the length in inches of each of its two parallel sides, add these lengths together, divide the sum by 2 and multiply the quotient so found by the length of the perpendicular between these sides, which will be either one-half inch or one inch. The product is the area of the trapezoid. Multiply this by the length of the tank in inches and divide by 231, and the quotient is the number of gallons contained in the portion of the tank included between two planes parallel to the axis and passing through the upper and lower sides, respectively, of the trap-

ezoid. The sum of this number and of the number previously obtained is the total number of gallons in the tank when it is filled to the same height as the upper side of the trapezoid. In the same way the number of gallons that the tank will hold for each strip represented by a trapezoid can be determined, and added to the total number of gallons for all the strips below it to get the total content of the tank up to that point. When the contents have been figured for each inch up to the centre, those for each inch above the centre can be obtained by adding, one at a time, the volumes of the corresponding strips, as already determined, since each strip in one semicircle will have its counterpart in the other.

For the tank specified in the question, the triangle judged to be equivalent to the segment with a height of one-half inch has a base of 9.22″ and an altitude of 0.73″. Its area is therefore $9.22 \times 0.365 = 3.37$ square inches. In the trapezoid immediately above it the lengths of the parallel sides are 9.84″ and 13.78″ respectively and the perpendicular distance between these sides is one-half inch. Its area is therefore $\frac{9.84 + 13.78}{2} \times \frac{1}{2} = \frac{23.62}{4} = 5.9$ square inches, and the total area of the segments with a height of one inch is $3.37 + 5.9 = 9.27$ square inches. The length of the tank is 20′ or 240″, so that the volume contained when it is filled to a depth of one inch is $9.27 \times 240 = 2224.8$ cubic inches, and the content in gallons is $\frac{2224.8}{231} = 9.6$ gallons. Working in this way the number of gallons contained for each inch in depth of the oil can be found and a table made up from which to determine the content for any given measurement.

The areas of the different segments can also be calculated by any one of the several rules given in engineering handbooks; but it takes much longer to do the work in this way than by the graphical method, and the errors in the results obtained by the latter are well within the limits of error due to inequalities in the tank itself. For tanks over eight feet in diameter, however, the graphical method can hardly be used on account of the difficulty of finding a suitable surface sufficiently large to hold the drawing. (Trustees.)

9. A calorimeter test made on a certain illuminating gas gave the following data: Gas consumed, 0.10 cubic foot; average temperature of water entering the calorimeter, 2.4° C.; average temperature of water leaving the calorimeter, 15.3° C.; quantity of water collected, 1505 c. c. (cubic centimetres); quantity of condensed water, 27 c. c. per cubic foot of gas; temperature of gas at meter, 46.5° F.; height of barometer, 29.33″. Calculate both the gross and the net calorific value of the gas.

Ans. Since, as stated in the answer to Question No. 9 of the Third Series for 1902, a litre (1000 c. c.) of water weighs 1 kilogram, and the amount of heat required to raise the temperature of 1 kilogram of water 1° centigrade is a calorie, the product obtained by multiplying the amount of water collected, measured in litres, by the number of centigrade degrees by which its temperature is raised, is the number of calories absorbed by the water, and, consequently, the number produced by the combustion of the measured quantity of gas.

In the particular experiment noted the water enters at a temperature of 2.4° C. and leaves at one of 15.3° C. The temperature is therefore raised 12.9° C. The volume of water collected is 1505 c. c., or 1.505 litres. The heat produced by the combustion of 0.1 cubic foot of gas is therefore $12.9 \times 1.505 = 19.41$ calories, and the gross calorific value per cubic foot measured at a temperature of 46.5° F. and a barometric pressure of 29.33″ is 194.1 calories. A calorie equals 3.968 B. T. U., so the corresponding value is $194.1 \times 3.968 = 770.19$ B. T. U. But from the tables for the correction of the volume of gases we find that the quantity of gas that occupies a volume of one cubic foot at a temperature of 46.5° F. and a pressure of 29.33″ will, under the standard conditions of a temperature of 60° F. and a pressure of 30″, occupy a volume of 1.011 cubic feet. Consequently, the gross calorific value of a foot of the gas under test, measured under the standard conditions, or, as it is called, the gross calorific value corrected for temperature and pressure, will be $\frac{770.19}{1.011} = 761.8$ B. T. U.

The net calorific value is obtained, as explained in the answer to Question No. 9 of the Third Series for 1902, by

deducting from the gross calorific value 2.38 B. T. U. for each cubic centimetre of condensed water collected per cubic foot of gas burned. In the present case 27 c. c. of condensed water were collected, so the uncorrected net calorific value is equal to $770.19 - (27 \times 2.38) = 770.19 - 64.26 = 705.93$ B. T. U. To obtain the net calorific value corrected for temperature and pressure, this must be divided by 1.011, for the reasons given above, and this corrected value is 698.24 B. T. U. (Trustees.)

10. It is desired to deliver 9,500 cubic feet of gas per hour through a pipe one mile long with a loss of pressure of 0.5″. The specific gravity of the gas is .55. What size pipe will be required? Give your calculations.

Ans. The answer to Question No. 11 of the Third Series for 1902 gives the formula by which the amount of gas flowing through pipes under different conditions can be calculated. This formula is :

$Q = 1350 \sqrt{\frac{d^5 p}{sl}}$, or, as it is also written,

$Q = 1350\, d^2 \sqrt{\frac{dp}{sl}}$, in which

Q = the number of cubic feet of gas delivered per hour,

d = the diameter of the pipe in inches,

p = the pressure, in inches of water, required for overcoming the friction in the pipe,

s = the specific gravity of the gas, air being 1.00, and

l = the length of the pipe in yards.

Squaring both sides of the equation we have

$$Q^2 = 1350^2 \frac{d^5 p}{sl}$$

Clearing of fractions gives,

$$Q^2 sl = 1350^2\, d^5 p,$$

and dividing both sides by $1350^2 p$

$$\frac{Q^2 sl}{1350^2 p} = d^5 \text{ or } d = \sqrt[5]{\frac{Q^2 sl}{1350^2 p}}$$

In the example given

Q = 9500

p = 0.5

$s = 0.55$ and

$l = 1760$ (1760 yards = 1 mile),

$$\text{so } d^5 = \frac{9500 \times 9500 \times 0.55 \times 1760}{1350 \times 1350 \times 0.5} = \frac{87{,}362{,}000{,}000}{911{,}250}$$

$= 95{,}870.5$ and $d = \sqrt[5]{95{,}870.5}$.

To avoid having to perform the operation of extracting the fifth root, the result can be reached by finding from a table of logarithms the logarithm of 95,870.5, dividing this logarithm by 5 and then finding the number for which this quotient is the logarithm. The number so found is the desired fifth root. The logarithm of 95,870.5 is 4.9816850, and this, divided by 5, is 0.9963370, the number corresponding to which is 9.916. Therefore, d = 9.916″, and 10″ pipe would be required.

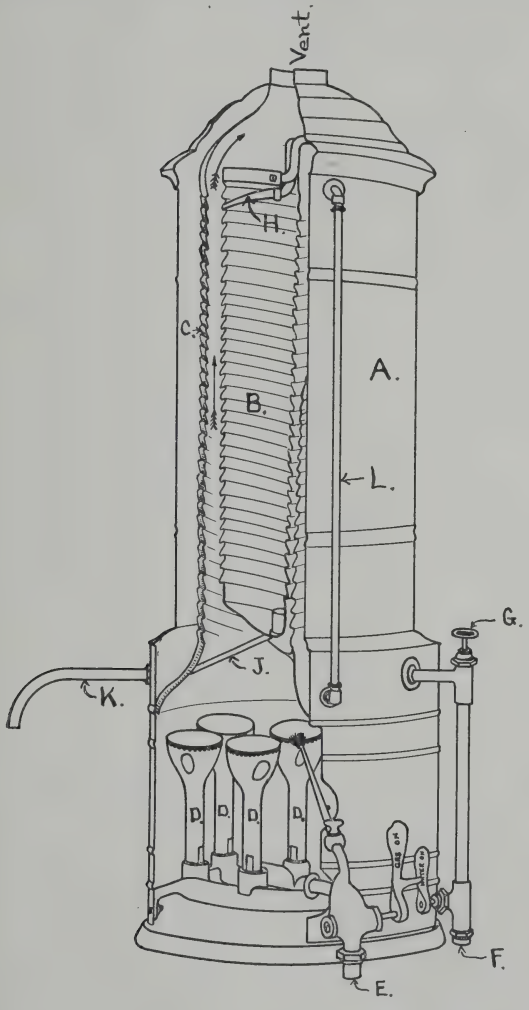
Since the pipe chosen will be that of the standard size that is nearest to and larger than the exact size given by the formula, the result can also be reached by trial after finding the value of d^5. In the case in point, since 100,000 is the fifth power of 10 and 59,049 the fifth power of 9, it is evident that the fifth root of 95,870.5 is very near 10, and that, therefore, 10″ pipe will be required.

The problem has been worked out above, since it is important to know how to use the formula; but in practice, problems of this kind are solved by the use of the gas flow computer referred to in the answer to Question No. 11 of the Third Series for 1902. (Trustees.)

11. Give a description, illustrated by sketches, of some form of instantaneous gas water-heater.

Ans. The name "Instantaneous" is given to a class of water-heaters in which the water is heated at the time when, and practically at the place at which, it is needed. Heaters of this class do not furnish any heated water to be stored up for future use and do not deliver water at sufficient head to enable it to be carried more than a few feet from the outlet of the heater itself. They work by causing the water that is to be heated to flow in thin streams over one surface of thin copper sheets, of comparatively large area, the other surface of these sheets being exposed to the heated products of the combustion of a comparatively large quantity of gas.

The heater illustrated on the accompanying cut consists of a copper cylinder, A, about 1 foot in diameter by 3 feet high, in which two spirally corrugated copper tubes, B and C, are



Instantaneous Water Heater.

set, the bottoms of these tubes being a sufficient distance above the bottom of the outer cylinder to leave ample space

for the gas burners, D, D, D, and also for a combustion chamber, above these burners, in which the combustion of the gas can be completed before the products strike the water-cooled surfaces of the tubes. The inner tube, B, is provided with a closed bottom, but is open on top. The outer tube, C, is fastened all around its bottom with a water-tight joint to the inside of the outer cylinder, A, and its top fits snugly against the vent opening at the top of the cylinder. The axis of each of the tubes and that of the cylinder all coincide, and the annular space between the tubes is about 1″ wide.

Gas is supplied by means of a pipe, E, which should be ¾″ in diameter. A pilot light is used to light the gas at the main burners as shown. The lever of the main gas cock has on it an arm so arranged that as the gas cock is opened this arm opens the main water cock on the pipe, F. It is thus impossible to turn on the gas without turning on the water, and there is no danger of the heater being damaged by being exposed to excessive heat owing to the gas being turned on while the water is shut off. After passing the main cock the water goes through a regulating valve, G, by which the quantity flowing can be regulated to suit the requirements as to the temperature at which it is to be delivered. It is then carried, by a pipe inside the inner tube, up to the top of this tube. From the end of this main supply pipe, branches are led to deliver the water directly on the inner surface of the inner tube and the outer surface of the outer one. One of these branches is shown at H. The water flowing over the inner tube follows the corrugations to the bottom, whence it flows through the pipe, J, into the bottom of the space between the outer tube and the cylinder, in which is also collected the water that has followed the corrugations of the outer tube. From this space it is delivered through one or more pipes, K, to the point, or points, where it is wanted.

As will be seen from the cut the only outlet for the products of the combustion of the gas is up through the annular space between the corrugated tubes. This space being narrow the products are brought into close contact with the metal and rapidly impart to it their heat, to be taken up by the water flowing over it. As the products and the water travel in

opposite directions, the water as it is heated flows over surfaces that are more and more highly heated and so is able to take up heat until it leaves the heater. The products of combustion, becoming cooler and cooler as they ascend, finally leave by the vent opening, which should always be connected to the outside air.

A gauge glass, L, is provided to show the height at which the water stands in the space between the outer tube and the cylinder, and thus call attention to the necessity for checking the flow by the regulating valve should the water be running in faster than it can be carried off by the delivery pipes.

Heaters of the style shown on the cut contain 10 to 11 square feet of heating surface, will raise the temperature of the water by 50° F. when it is flowing at the rate of from 1½ to 2 gallons per minute, and will consume about 1 cubic foot of gas for each 1 to 1½ gallons of water heated.

As will be seen by the cut the water and the products of combustion do not come into contact with one another in such heaters and the water heated by them can be used for cooking as well as for washing. Another style of heater is made in which the water and products of combustion do come into contact with each other, and such heaters can be used only for water that is not to be taken internally. (Trustees.)

12. State some of the reasons for the increasing use of Portland cement concrete in the place of brick or stone masonry.

Ans. One of the principal reasons for the increased use of Portland cement concrete in the place of brick and stone masonry is found in the growth of knowledge as to the advantages and capabilities of concrete. When necessary it can be made to excel in strength and durability all other masonry except that made from the very best stone, while when great strength is not required it can be made less strong, with a reduction in cost that cannot be had under similar circumstances with brick or stone masonry. On foundation work it can be put in with a smaller expense for excavation and will give a more coherent, homogeneous structure, and one that is less subject to unequal settling, in case the soil is not uniform over

its whole area, than will be the case with stone. It can be made water-tight more easily than brick or stone. Under ordinary conditions as to the respective costs of the different kinds of materials it is cheaper than brick or stone masonry.

In addition to the recognition of its possession of the advantages named above, another important reason for the increased use of concrete in large cities is that it can be made and put in place by unskilled labor, and work in which it is used instead of brick or stone is thus free from the vexatious and costly delays that are apt to be experienced with other masonry, owing to the strikes declared for trivial causes by the masons' unions to which practically all the masons in such cities belong. This ability to use unskilled labor also frequently permits of the work being executed more rapidly on account of there being available more laborers than brick or stone masons. These considerations of freedom from union interference and ability to secure unskilled labor more easily than skilled, have been very important ones in large cities during the past few years. (Trustees.)

Circular to Members of the Section of 1906—Practical Class.

You will find enclosed the first series of twelve questions for your section. A similar series will be sent out each three months, but no series will be sent to any member of the class who has not sent in answers to the questions of the preceding series within the time specified for the receipt of such answers, or failing this has secured an extension of time by presenting to the Secretary a good and valid excuse for such failure. All answers will be carefully examined by the Secretary, and each member of the regular class will be sent a criticism of his work on each series of questions based upon such examination. Members of the class should, therefore, keep copies of their answers, in order to fully understand the criticisms. Those members of the class who answer all the questions as sent out will be continued in the class for three years, this period having been fixed upon by the Trustees as the length of time to be given to the course.

Before making up their answers the students are at liberty to use any and all means of securing information at their disposal, with the following exception: Some of the questions having already been used for previous sections, the answers to them have been published in the Proceedings of the American Gas Light Association. The answers thus published should not be consulted by the student while preparing his answers. Answers should be written, as far as possible, in the student's own language, based upon the knowledge acquired through his study of the subjects covered by the questions, and not copied directly from any text book or other source of information, and care should be taken that the desired meaning is clearly and concisely expressed, and that reasons are given for the statements made.

It is assumed by the Trustees that admission to the class is sought solely from an earnest desire to derive all the benefit that can be obtained from the work carried on by its members. It is therefore expected that the members of this new section will work faithfully and adhere strictly to the rules governing the time for sending in answers.

Answers to this first series must be in the hands of the Secretary not later than March 1st.

Please write your name and address at the head of the first page of answers.

Please write your answers on one side of the paper only.

The Secretary will be pleased to hear from any member of the class who does not understand any questions, and will endeavor, to the best of his ability, to help any such inquirer out of his difficulty.

Please address all communications, answers to questions, etc., to Alfred E. Forstall, Secretary, Room 22, 58 William Street, New York City, and put on the envelope your name and address.

January, 1903.

FIRST SERIES OF QUESTIONS—SECTION OF 1906—PRACTICAL CLASS—AMERICAN GAS LIGHT ASSOCIATION.

1. What is coal gas? What is water gas? What is carburetted water gas? What is oil gas? What is the average composition of each kind of gas?

2. What are the properties that must be possessed by a coal to fit it for being used for the manufacture of coal gas?

3. Name the chief impurities in crude coal gas as it leaves the retorts, and give the reasons why they should be removed from the gas before it is distributed.

4. Name the useful by-products or residuals produced in addition to the gas in the manufacture of coal gas. In the manufacture of carburetted water gas.

5. Name the principal pieces of apparatus necessary in a carburetted water gas works, and state briefly the function of each.

6. Name the principal pieces of apparatus necessary in a coal gas works, and state briefly the function of each.

7. What does the ordinary U or syphon gauge indicate, and what is the object of its use in gas works?

8. How does a suction pump "draw" water? Why and how does a hot chimney "draw?"

9. Why is it necessary to provide for draining all mains and pipes through which gas travels, and how is this done?

10. What is the commonly accepted theory as to the cause of the luminosity of the flame produced by burning illuminating gas in a luminous burner?

11. Why is the flame of a Bunsen or atmospheric burner non-luminous?

12. What is common lime, and what is the raw material used in its manufacture? What is hydraulic lime, and what is the raw material used in its manufacture? What is hydraulic cement, and what is the raw material used in the manufacture of natural hydraulic cement?

(Answers to these questions are due March 1, 1903.)

Answers to First Series of Questions—Section of 1906—Practical Class—American Gas Light Association.

Answers to all of these questions have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 1, Vol. XVII, page 71.
No. 2, Vol. XVII, page 72.
No. 3, Vol. XVII, page 73.
No. 4, Vol. XVII, page 74.
No. 5, Vol. XVII, page 75.
No. 6, Vol. XVII, page 74.
No. 7, Vol. XVII, page 75.
No. 8, Vol. XVIII, page 93.
No. 9, Vol. XVII, page 77.
No. 10, Vol. XVIII, page 94.
No. 11, Vol. XVIII, page 95.
No. 12, Vol. XVII, page 78.

Fourth Series of Questions, 1902—Third Section—Practical Class—American Gas Light Association.

1. A net ton of one of two gas coals that are available for use yields 9,000 cu. ft. of gas, 700 lbs. of coke for sale, 11 gallons of tar, and 4 lbs. of pure ammonia, while a net ton of the other yields 9,800 cu. ft. of gas, 800 lbs. of coke for sale, 12 gallons of tar and 5 lbs. of pure ammonia. The average make per retort per 24 hours is 8,100 cu. ft. with the first coal and 8,820 cu. ft. with the second. In both cases retort house labor costs $4.00 per each six retorts per 24 hours and the prices for the products are: Gas, $1.25 net per 1,000 cu. ft.; coke, $4.00 per net ton; tar, 3c. per gallon, and ammonia, 5c. per pound. The first coal costs $2.50 per net ton. What is the equivalent price of the second?

2. Describe briefly and generally some method of charging and drawing gas retorts, in which hand labor is assisted by

mechanical appliances, so arranged as to render the work easier and to enable it to be done by fewer men.

3. Give a description, illustrated with sketches, of some form of hand pump used for pumping the drips on the inlet and outlet pipes of gas holders in brick tanks.

4. In the manufacture of carburetted water gas it has been found that with the ordinary methods of condensing and tar extracting some vapors remain in the gas until the purifiers are reached and are then deposited in the purifying material with the effect of shortening its life. What has been found to be an efficient way of removing these vapors before the purifiers are reached?

5. How should the process of washing and scrubbing coal gas be carried on to make the ammonia combine with the greatest possible amount of carbonic acid and sulphuretted hydrogen, and thus relieve the purifiers of work that they would otherwise be called upon to do?

6. What is meant by electrolysis as applied to gas mains and what is its chief cause?

7. What are the respective advantages and disadvantages of cast and wrought iron pipes for use as gas mains?

8. Give a description, illustrated with sketches, of some form of recording pressure gauge used for taking street main pressures.

9. In putting in gas piping that will be exposed to extreme cold, such as the risers in street lamp posts or the portions of mains on bridges, what method would you adopt to guard against the obstruction of the pipe by frost?

10. What is the "Principle of the Conservation of Energy," and how would you apply it to check up the claims made as to the results to be obtained from a new process for making gas?

11. Describe the cycle or series of operations and the method of governing employed in each of the following gas engines, Otto, Westinghouse and Körting.

12. Should the lining in the generator of a carburetted water gas apparatus be made single or double? Give the reasons for your answer.

(Answers to these questions are due March 15, 1903.)

Answers to Fourth Series of Questions, 1902—Third Section—Practical Class—American Gas Light Association.

Anwers to Questions Nos. 2 and 4 have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 2, Vol. XVI, page 33.
No. 4, Vol. XVI, page 85.

The answers to the other questions are as follows:

1. A net ton of one of two gas coals that are available for use yields 9,000 cubic feet of gas, 700 pounds of coke for sale, 11 gallons of tar and four pounds of pure ammonia, while a net ton of the other yields 9,800 cubic feet of gas, 800 pounds of coke for sale, 12 gallons of tar and 5 pounds of pure ammonia. The average make per retort per 24 hours is 8,100 cu. ft. with the first coal and 8,820 cubic feet with the second. In both cases retort house labor costs $4.00 per each six retorts per 24 hours and the prices for the products are: Gas, $1.25 net per 1,000 cubic feet; coke, $4.00 per net ton; tar, 3 cents per gallon, and ammonia, 5 cents per pound. The first coal costs $2.50 per net ton. What is the equivalent price of the second?

Ans. To solve the problem set in the question it is necessary to determine the price at which the second coal would have to be bought in order to make the cost of gas in the holder per 1,000 cubic feet the same as it is with the first coal at $2.50. The only items in this cost that are taken as varying are the cost of coal and that of retort house labor. With

coal No. 1 the net cost of coal, after deducting the value of the residuals produced, is,

Gross cost of coal		$2.50
Less—Coke, 700 pounds @ $4.00 per 2,000 pounds	$1.40	
Tar, 11 gallons @ 3c.	.33	
Ammonia, 4 lbs. @ 5c.	.20	1.93
Net cost of coal per ton		$0.57

As each ton of coal yields 9,000 cubic feet of gas the net cost of coal per 1,000 cubic feet is $\frac{57}{9} = 6.33$ cents. Since the retort house labor costs $4.00 per 24 hours for six retorts, and the yield of gas per retort per 24 hours is 8,100 cubic feet, the cost of retort house labor per 1,000 cubic feet is $\frac{400}{486} = 8.23$ cents. With coal No. 1 at $2.50 per ton the combined cost of coal net and retort house labor is therefore 6.33 cents + 8.23 cents = 14.56 cents.

In the case of coal No. 2 the cost of retort house labor being, as above, $4.00 per 24 hours for six retorts and the yield of gas per retort per 24 hours 8,820 cubic feet, the cost of retort house labor per 1,000 cubic feet is $\frac{400}{52.92} = 7.56$ cents. As the cost of retort house labor and the net cost of coal are assumed to be the only variable items in the cost of the gas per 1,000 cubic feet in the holder, the sum of these two items must be the same in the two cases to make this holder cost the same. Hence, the net cost of coal per 1,000 cubic feet must be 14.56 cents—7.56 cents = 7.0 cents. The yield of gas per ton being 9,800 cubic feet the corresponding net cost of coal per ton will be $9.8 \times 7 = 68.6$ cents and the gross cost will be,

Net cost of coal		$0.686
Add—Coke 800 pounds @ $4.00 per 2,000.	$1.60	
Tar 12 gallons @ 3c.	.36	
Ammonia 5 pounds @ 5c.	.25	2.21
Gross cost of coal per net ton		$2.896

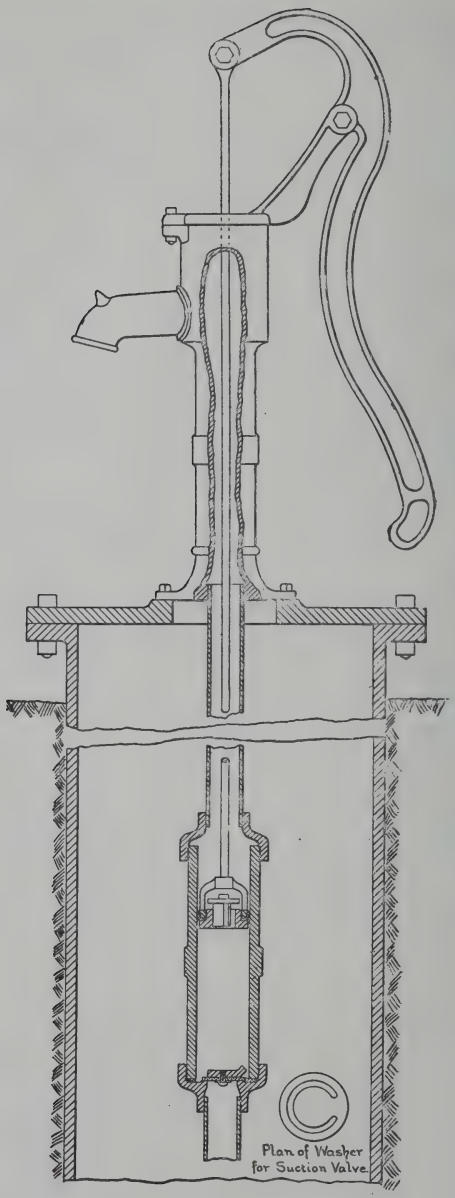
or, say, $2.90. That is, the cost of gas per 1,000 cubic feet in the holder will be the same with coal No. 2 at $2.90 per net ton as it is with coal No. 1 at $2.50, and therefore $2.90 is

the highest price per net ton that can be paid for coal No. 2 in competition with coal No. 1 at $2.50 per net ton. (Trustees.)

3. Give a description, illustrated with sketches, of some form of hand pump used for pumping the drips on the inlet and outlet pipes of gas holders in brick tanks.

Ans. As the drips on the inlet and outlet pipes of gas holders in brick tanks are usually so far below the surface of the ground that an ordinary suction pump placed at the ground level would have too long a suction pipe to work satisfactorily, it is customary to use a form of deep well pump for pumping them. This kind of pump has the further advantage of being removed from any danger of freezing, so that it is not necessary to protect it from cold.

A form of deep well pump that is frequently used for gas holder drips is shown on the accompanying cut. The pump proper consists of a cylindrical cast iron barrel, of suitable diameter and length, threaded at each end to receive caps similar in form to reducing couplings, these caps being threaded both to screw on the barrel and to receive a pipe of the desired size. The interior of the barrel is bored true. The piston is made in two parts, an upper and a lower. The upper part is an internally threaded ring provided with a yoke tapped for the insertion of the piston rod. On the outside the lower part of this ring is turned down to form a recess into which the upturned edge of a leather washer can fit. The lower part is in form like a bushing, but has no internal thread. The portion having the smaller diameter is threaded externally to fit the internal thread of the upper part of the piston, and its end is finished to furnish a seat for a cast iron poppet valve. These parts of the piston are not finished and have a little smaller diameter than the barrel, but it is made to work air- and water-tight in the barrel by a leather washer held between the two parts and of such a diameter as to be turned up into the recess in the upper part when the piston is pushed into the barrel. When turned up in this way the tendency to flatten out keeps it pressed tightly against the wall of the barrel. In putting the piston together the valve is put in place on top



Pump for Gasholder Drips.

of the lower part, the leather washer is put on outside of the threaded portion of this part, and the two parts are then screwed together, the washer being held between them.

The bottom valve is formed by a leather washer cut to the shape shown on the cut. The outer ring of leather is held between the lower end of the barrel and the bottom cap, and the flap, weighted with a small circular cast iron weight fastened to it by a round headed screw and washer, acts as the valve, the narrow neck serving as a hinge. The lower cap is made with a raised ring finished to furnish a seat for this valve.

This pump is placed at any convenient height in the inlet or outlet pipe, being usually set from five to ten feet above the bottom of the drip, a suction pipe being run from the lower end to the bottom of the drip and a discharge pipe from the upper end to the base of the stand which forms the external discharge pipe and furnishes a support for the handle by means of which the piston is moved up and down. This stand is in appearance exactly like an ordinary suction pump, but, of course, contains neither piston nor valves, being, as stated, simply a continuation of the discharge pipe. Its base is threaded internally to receive the pipe coming up from the pump barrel, and is provided with a flange by which it is bolted to the flange covering the top of the inlet or outlet pipe. This cover flange is provided in the centre with a circular hole through which the pump can be put in or taken out in case it is necessary to repair it.

Before being put in to the pipe the suction pipe is screwed to the pump, the piston rod, which may be either a rod or a pipe, made the proper length, the discharge pipe screwed to the pump and then to the base of the stand, the piston rod fastened to the pump handle, and the whole thing is then put into place with the pump, supported from the stand, inside the pipe and at the desired height above the bottom of the drip.

A small hole should be drilled in the discharge pipe just above the pump, so that when pumping is stopped, the water in the stand and in the discharge pipe above this hole will run out and all danger of its freezing be avoided. A means of testing the working of the pump should also be provided by put-

ting in a small pipe opening above the cover flange and running down into the drip to a point say two inches above the lower end of the suction pipe. The upper end of this pipe being closed by a stopcock, this stopcock is opened when the pump ceases to raise water. If gas blows when this is done the drip is dry, if it does not, the pump is out of order and should be repaired. (Trustees.)

5. How should the process of washing and scrubbing coal gas be carried on to make the ammonia combine with the greatest possible amount of carbonic acid and sulphuretted hydrogen, and thus relieve the purifiers of work that they would otherwise be called upon to do?

Ans. In order that the ammonia in coal gas shall be made to combine with the greatest possible amount of carbonic acid and sulphuretted hydrogen, it is necessary to so present to the gas the ammoniacal liquor formed in the hydraulic main and condensers as to give the uncombined ammonia, which forms a large proportion of the total amount of ammonia in such liquor, an opportunity to combine with the carbonic acid and sulphuretted hydrogen in the gas.

The way in which this can be done depends upon the equipment of the works in scrubbers. If tower scrubbers are used at least two should be provided, the gas passing first through one and then through the other. In the first one that it enters the gas should be scrubbed with the liquor from the hydraulic main and condensers mixed with the weak liquor from the second scrubber in which clean water is used to remove the last traces of ammonia. If a rotary mechanical scrubber is used, the liquor from the hydraulic main and condenser can be introduced into, say, the middle compartment, where it mixes with the liquor formed in the compartments on the gas outlet end, at which clean water is admitted, and in connection with this liquor is used to scrub the gas as it passes through the compartments on the gas inlet end.

In England, where the gas coals contain more sulphur than do those most extensively used in this country, and where, consequently, it is more important to make the ammonia combine with all the sulphuretted hydrogen that it can, tower

scrubbers and mechanical scrubbers are sometimes used in series, the gas passing first through the tower scrubber, where it meets the hydraulic main and condenser liquor mixed with liquor from the mechanical scrubber, into which it passes after leaving the tower scrubber and which is supplied with clean water at the rate of from one to one and a half gallons per 1,000 cubic feet of gas made.

In places where the cheapest coals contain a comparatively large percentage of sulphur, the cost of purification can be considerably reduced by so arranging and handling the apparatus as to take full advantage of the power of the ammonia to combine with sulphuretted hydrogen. (Trustees.)

6. What is meant by electrolysis as applied to gas mains and what is its chief cause?

Ans. When applied to gas mains electrolysis is used to denote the corrosion caused by the action of electric currents at the points where these currents leave the gas mains, along which they have previously been traveling, to pass through damp earth to some other conductor that offers a path with a smaller resistance. The process by which the corrosion takes place is exactly similar to what would happen if, in the often shown experiment of decomposing water by means of electricity, iron plates were substituted for the platinum plates that are used as the poles or electrodes. If this were done, the oxygen that gathers around the positive electrode, or anode, would, in combination with the acid in the water, attack the iron and cause it to rust away. This is exactly what happens to the iron of a gas main when an electric current passes from it into damp earth on its way to another conductor. Such earth almost always contains so-called salts, that is, substances formed by the combination of an acid and a base, which are soluble in water, and the current really travels through a solution of these salts. Such a solution is decomposed by the electricity into its acid and basic components, and the acid gathering around the positive electrode, which is the pipe at the place where the current leaves it, attacks the metal, the particles of which are carried with the current through the solution towards the negative electrode.

The extent of the corrosion and the rapidity with which it takes place depend upon the amount of moisture in the earth and the quantity of current leaving the pipe. In very dry earth the action is very slow, but in earth that is quite moist it may, when sufficient current passes, proceed very rapidly.

The chief source of the electric currents which travel along the gas mains and leaving them set up electrolytic corrosion at the points of departure, are the return currents of single trolley wire electric railways. These return currents are supposed to travel back through the rails to points near the power house, from which they reach the negative side of the dynamos by means of return conductors bonded to the rails. As a matter of fact, a greater or less quantity of current, the amount depending on the character of the bonding between the separate lengths of rail and the extent to which insulated return conductors are used, leaks into the ground and finds its way to the gas and water pipes, which offer a path of small resistance as long as they run toward the power house. When the vicinity of the power house is reached, or when the pipes turn to go in a direction that takes them farther away from the power house, they no longer offer the path of least resistance, and the current leaves them to go back to the rails or to some other pipe that continues in the proper direction. As stated above, it is at the points where the current thus leaves the pipe that the electrolytic action occurs. The current may also leave the pipe at points where its conductivity is destroyed or reduced by a joint, even if it again returns to the pipe a little farther along, and electrolysis will also take place at such points.

Electrolysis of gas mains cannot be completely prevented as long as the rails are used as return conductors, but the extent to which it occurs can be reduced by careful bonding of the rails, by the provision of insulated return conductors connected to the rails at intervals, and by reducing the conductivity of the gas mains to as low a point as possible, so as to make them unattractive as paths for the stray currents.

A committee of the Western Gas Association made, in 1894, a very complete report upon the causes of electrolysis and the best means of preventing it. This report can be

found in the Proceedings of that Association at page 271 of the volume containing the report of the meeting in 1894, or in the *American Gas Light Journal*, Vol. LXI, page 765, or in *Progressive Age*, Vol. XII, page 222. (Trustees.)

7. What are the respective advantages and disadvantages of cast and wrought iron pipes for use as gas mains?

Ans. The advantages of cast iron, as compared with wrought iron pipe, for use as gas mains, are greater ability to withstand any corrosive action of the soil in which it is laid, and consequent longer life, greater thickness for equivalent internal diameters, giving a better joint for service connections tapped directly into the main, and, in sizes from 6″ to 30″, inclusive, in diameter, smaller first cost. The disadvantages of cast iron pipe are, the necessity for a greater number of joints of a form more difficult to make tight originally, and to keep tight throughout the life of the pipe, than is the form of joint used in wrought iron pipe, and the brittleness of cast iron which renders it liable to break under shocks from extraordinary traffic on the street in which it is laid, or from strains thrown upon it through subsidences, due either to a disturbance of its foundation or to this foundation being originally insecure. The advantages and disadvantages of wrought iron pipe as compared with cast iron are of course the converse of the above.

In good soils cast iron will last indefinitely, and even under the worst conditions it will have a life of some years. Comparatively little wrought iron pipe has been used for gas mains, and none of this dates back far enough to furnish conclusive data as to the number of years that can be safely counted upon as the life, under ordinary gas distribution conditions, of such pipe when covered with a good protective coating of the kind described in the answer to a previous question. Experience with coated services shows, however, that when the conditions are at all bad, wrought iron corrodes much faster than cast iron, and that even under comparatively favorable conditions a very perfect coating is necessary to make a life of twenty to thirty years reasonably certain.

The greater thickness of cast iron pipes permits the securing of sufficient depth of thread to make a good screw joint in the wall of the pipe itself, so that there is no necessity for using the service clips or saddles, without which a good joint cannot be obtained with wrought iron pipe. The use of these clips adds not only to the cost of the services, but also to the opportunity for leakage at the service connections.

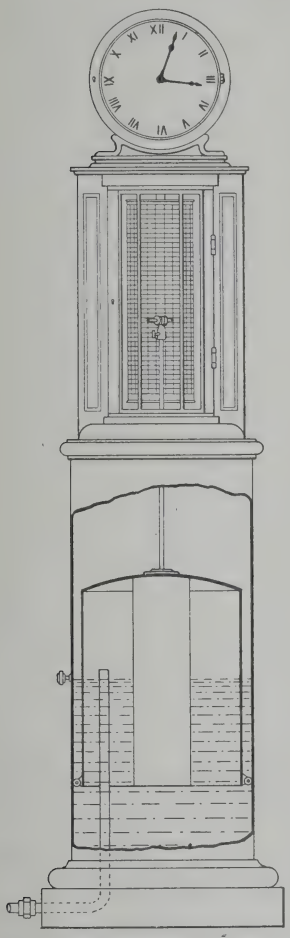
In the smaller sizes, 3″ and 4″, however, wrought iron pipe can be laid, under normal conditions of price, more cheaply than cast iron pipe, and in small towns or the residential suburbs of large cities, where the soil is good, the services will never average less than 50′ apart and the probable consumption will never exceed the capacity of the above sizes, the advantages of wrought iron outweigh the disadvantage of possibly shorter life, and it is good practice to use it.

Another place where the use of wrought iron is advantageous is in the case of a line to be laid up a hill where the ditch would have to be blasted out of rock, and where there is an opportunity to use a ditch already made for a sewer or a water pipe. A line of cast iron pipe could not be maintained in such a location, while the wrought iron pipe is strong enough not to be broken by any settling, and the line being laid on a slope there is little danger of its becoming trapped. (Trustees.)

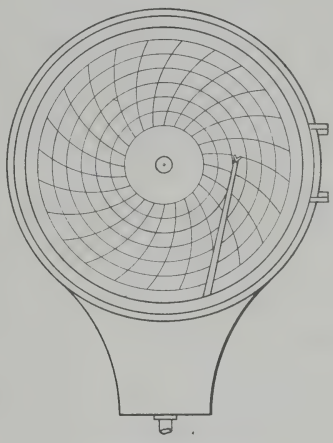
8. Give a description, illustrated with sketches, of some form of recording pressure gauge used for taking street main pressures.

Ans. The form of recording pressure gauge that it is desirable to use for taking street main pressures depends somewhat upon whether these pressures are to be taken, at any one location, continuously or for a day or two only. Where pressures are to be taken continuously, as at the gas works or the gas office, it is best to use a gauge which measures the pressure by the height to which a small bell sealed in water is raised by the gas admitted under it, since such gauges are the least subject to get out of order and give inaccurate records. Where pressures are to be taken only for a day or two a year, it is advisable, for the sake of its greater portability, to use a gauge

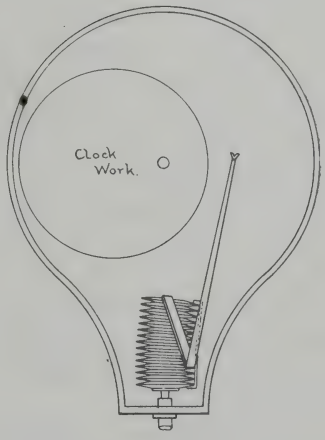
based on the aneroid barometer principle, even though it is necessary to exercise greater care in using it.



Float Gauge.



Bristol Gauge.



Recording Pressure Gauges.

A gauge of the class first mentioned, which may be called a "Float Gauge," is shown, partly in elevation and partly in section, on the left half of the accompanying cut. Outwardly it consists of a tinned iron cylindrical case containing the bell

and the sealing water, and surmounted by a half cylinder, also of tinned iron, the front of which is closed by a glazed door in the shape of half of a hexagonal prism, which contains the recording apparatus. At the top is a clock by which the recording mechanism is driven.

The bell, by the motion of which the pressure is measured, is made of tinned iron, and is provided with a cylindrical float, made concentric with the bell, with such an area that when submerged in water to the full depth of the bell, the weight of the water that it displaces is just equal to that of the bell and its appurtenances, so that when the bell is at the lowest point to which it can sink, it is just afloat when the pressure inside of it is equal to that of the atmosphere, and therefore is ready to rise as soon as the interior pressure exceeds that of the atmosphere. This bell is guided by wheels fastened around its lower edge and working on guides fastened to the case, and by a rod fastened to the centre of the top and passing up through a small hole in the top of the lower part of the case into the space containing the recording mechanism. Gas from the street main, the pressure in which is to be recorded, is brought under the bell by means of a pipe entering through the base of the case and rising above the water line. A plug with a milled head is placed in the side of the case to drain off any water that may be run in above the water line and there is an outlet at the bottom for running off all the water. An opening, closed with a plug, is provided on the side of the case above the water line for putting in water when necessary. The stopcock on the gas pipe is usually made with a small side outlet so that when the gas is shut off the interior of the bell is put into communication with the atmosphere through this side opening.

The height to which the bell will rise for each 1/10″ gauge pressure possessed by the gas admitted under it, depends upon its weight, its height and the area of the annular space between the circumference of the bell and the float. It is evident that when the total pressure exerted by the gas on the crown of the bell is equal to the weight of the bell and its appurtenances the bell will rise to its full height, since the whole weight will be supported by the gas, and therefore the float

having no weight to carry will be forced up by the water until its bottom is on the level of the surface of the latter. The total pressure is equal to the gauge pressure of the gas multiplied by the area of the portion of the crown on which the pressure is exerted, and the weight in pounds that will be supported by this pressure is equal to the gauge pressure, in inches of water, multiplied by the area, in square inches, of the portion of the crown on which the pressure is exerted multiplied by 0.036, the weight, in pounds, of a cubic inch of water. Conversely, the pressure in inches required to fully raise a bell, the weight and effective area of which are known, is equal to the weight divided by the product of the area and 0.036. In any given case, therefore, knowing the dimensions of the bell and of the float and the total weight, the pressure required to raise the bell to its full height can be calculated, and by dividing the height by the number of tenths of an inch in the pressure so determined the amount of rise for each 1/10″ of pressure is obtained. Or, since this rise must be just sufficient to reduce the volume of water displaced by the float by an amount the weight of which is just equal to the total pressure exerted on the top of the bell by a pressure of 1/10″ of water, knowing the diameter of the float, the rise can be calculated directly by dividing the product of the area, in square inches, of the annular space of the bell and 0.0036 by the product of the area, in square inches, of the float and 0.036, or, what is the same thing, as can be seen by cancelling, by dividing the area, in square inches, of the annular space in the bell by the area of the float multiplied by 10.

The recording mechanism consists of a cylindrical drum supported on a central pivot at the bottom and connected by a central rod at the top to a shaft coming down from the clock. This connection is made in such a way that it can be readily broken and the drum removed. The shaft is so geared to the clockwork that it makes one complete revolution in twenty-four hours, carrying the drum with it when the connection is made. A sheet of paper ruled with vertical lines to show the time and horizontal lines for the pressure is wrapped around this drum and fastened so as to be carried around with it as it revolves. A pencil mounted on top of the rod carried by the

bell is pressed by a light spring against the paper and makes a continuous line recording the pressure throughout the twenty-four hours. The vertical ruling marking the time is made by dividing the space equal in length to the circumference of the drum into twenty-four equal parts, so that in each hour one of these spaces passes under the pencil point. The proper distance between the horizontal lines marking the pressures is calculated in the manner explained above and the paper ruled accordingly. Both the vertical and horizontal lines are suitably marked to enable the pressure and time corresponding to any point on the sheet to be read off at a glance.

In starting a record the paper must be so placed on the drum, that when the bell is open to atmospheric pressure the pencil point touches the line of zero pressure at the point corresponding to the time at which the start is made.

The Bristol gauge, one of the second class, is illustrated on the right half of the cut. The lower figure shows the pressure indicating mechanism and the upper figure shows a front view of the gauge with the card in place, so that the manner in which this card is ruled can be seen.

Both the indicating and the recording mechanism are contained in one cast iron case, which is a shallow box of an inverted pear-shaped section. The elongated part at the bottom is covered over with a solid cover, while the upper part is provided with a circular, glazed door.

The pressure indicating mechanism, contained in the elongated portion of the case, consists of a number of rings made of thin corrugated brass fastened together so as to form a gas-tight vessel similar to an accordion in shape. The corrugations on each ring are arranged in circles concentric with its edges. The metal being very thin the effect of even a very slight increase in the pressure inside the vessel is to flatten the corrugations, thus increasing the width of the rings and producing an elongation of the vessel. When one side is prevented from lengthening by means of a flexible strip, placed against it and fastened to the top and bottom rings by turned-over ends, the effect of the pressure is to cause the vessel to become curved, the top plate being tilted and its centre thrown off the vertical line to the side on which the strip is

fastened. The greater the pressure the greater the curvature and the greater the tilting of the top plate and the displacement of its centre from the vertical line. By means of this tilting and displacement, the point of a bent arm attached to the top plate of the vessel is moved, along the arc of a circle, farther away from the vertical line as the pressure increases.

The record of pressures is obtained by providing the point of this arm with means of making a continuous line on a circular card fastened to a plate, which is caused by clock-work to make one revolution in twenty-four hours. The pressure lines are concentric circles placed the proper distance apart, while the lines marking the time are arcs of circles corresponding to the arc along which the marking point travels as the pressure rises and falls. Both sets of lines are so marked as to enable the pressure and time corresponding to any point on the card to be noted at a glance.

Owing to the lightness of its parts a gauge of this kind cannot stand rough usage, and must be very carefully handled to prevent its getting out of order and to keep it accurate. (Trustees.)

9. In putting in gas piping that will be exposed to extreme cold, such as the risers in street lamp posts or the portions of mains on bridges, what method would you adopt to guard against the obstruction of the pipe by frost?

Ans. Obstructions to gas pipes by frost may be guarded against either,

By enlarging the portion of the pipe in which the frost tends to accumulate, to such an extent that a passage of sufficient size will remain for the gas even after the frost has accumulated on the interior surface of the pipe to a thickness that makes it an efficient non-conductor of heat and so prevents any further formation, or,

By covering the outside of the pipe with a non-conducting coating which prevents the gas from being cooled to the frost producing temperature, or,

By providing means for readily removing the frost when it has collected in sufficient quantity to begin to unduly restrict the flow of gas through the pipe.

The first method is preferable wherever the extra size of pipe called for is neither inconvenient nor expensive. It is applied to lamp risers by the use of about thirty inches of 1½″ pipe, called an "anti-freezer," extending up from the service to about one foot above ground. The remainder of the lamp riser is of the usual size, ¾″ or ½″, and the greater area of the 1½″ pipe allows much frost to be deposited in it, before it is closed up, and it is found in practice, that in the latitude of the Northern States, the winters are seldom severe enough to cause the anti-freezer to become stopped up. The location of the anti-freezer, just where the gas goes through the cold ground and first strikes the air, ensures that all condensation will occur in it. For bridge crossings, where the main is small, 6″, or less, in diameter, this method is applied by increasing the diameter of the pipe by 2″ from a point in advance of that at which the exposure to cold begins on one side to a point beyond that at which this exposure ends on the other side. If the pipe rises from the ground to cross on top of the bridge, the larger size should be used from the beginning of the rise on the one side to the end of the drop on the other, while if the pipe crosses under the bridge and on practically the level at which it is laid on the approaches, the enlargements should be made on each side at a distance back from the face of the abutment at least equal to the depth to which the pipe is covered plus one foot. When wrought iron pipe is used for the crossing, a piece of pipe of the same size as the main in the ground is sometimes inserted loosely in the enlarged portion, as a precaution against the obstruction of the passage by accumulations, on the bottom, of frost shaken loose from the top, the two pipes being kept concentric by proper distance pieces. The frost forms in the annular space and leaves the inner pipe entirely unobstructed and surrounded by a good non-conductor.

When the pipe is small and the conditions are such that a non-conducting covering on the outside of the pipe can be applied cheaply and will not be exposed to undue wear and tear, the second method is preferable to either of the others.

The third method, that of providing means for dissolving, or otherwise removing, frost as it forms, is to be preferred to

the others in case of large pipe on bridges. Where the supply demands a pipe 6″ or larger, and the climate is so severe that frost enough would form to seriously diminish or to stop the flow of gas, openings should be provided in the bridge line for the introduction of a solvent for the frost, such as wood alcohol. Ordinarily, holes tapped in the line at high points, say about twenty feet apart, will suffice. One or two such holes should also be provided in case of emergency, even when the method of enlargement is adopted. In very large lines, 16″ and over in size, tees might be put on each side of the bridge where the line comes out of the ground, the free outlets of these tees being made flanged and closed with blank flanges. This would provide against extremely large deposits of frost, for full access to the line would be obtained by removing these flanges. There should be a valve on each side of the bridge to permit the bridge line to be cut out. Where the bridge line furnished the only supply to the district on the farther side a temporary bye-pass line would have to be laid before the valves were closed. (Trustees.)

10. What is the "Principle of the Conservation of Energy," and how would you apply it to check up the claims made as to the results to be obtained from a new process for making gas?

Ans. The "Principle of the Conservation of Energy" is that the total energy of the universe is constant, no energy being created or destroyed in any of the processes of nature, every gain or loss in one form of energy corresponding precisely to a loss or gain in some other form or forms. (Century Dictionary.)

This principle follows from the still broader one, that "all that exists, whether matter or force, and in whatever form, is indestructible by any definite power," the truth of which has been, and is being, more and more firmly established by all the researches of science.

From it we reason that in no case can the sum of the energies (actual and potential) possessed by the products of any combination of different forces or bodies be greater than the sum of the energies possessed by the original forces or bodies

before they entered into combination. And in regard to machines "that it is impossible by any combination of natural forces to make a machine, whose parts being once set in motion and then left to the operation of gravity, or other similar forces, and their own mutual action, shall later return to their original positions with greater velocities" (and consequently greater energies) "than they at first possessed," or, in other words, it is impossible to make "a machine, which being put into motion, and left to itself, will, in a certain time, regain its original velocity, and at the same time impart to some body, originally at rest, a certain velocity."

To apply this principle to check up the claims made as to the results obtained from any process for making gas, it is merely necessary to determine the relation between the sum of the energies possessed by the products of the process and the sum of the energies possessed by the raw materials employed, bearing in mind that the energies possessed by the products not only can never exceed the energies possessed by the raw materials, but will never even equal them, since in making gas it is impossible to avoid losses by radiation of heat and also by heat carried away in the waste products. If, when the claims put forth are analyzed, it is seen that the total energy claimed to be available as a result of the process is greater than, or even exactly equal to, the total energy put in, these claims can safely be dismissed as absurd. In many cases it is very easy to disprove the claims made as to the results of gas-making processes by a comparison between the sum of the heating values of the materials employed and that of the same values of the products, and although it may be difficult to make the comparison in some cases, it will, when properly made, always tell whether the results reported are reasonable or not. (Trustees.)

11. Describe the cycle or series of operations and the method of governing employed in each of the following gas engines: Otto, Westinghouse and Körting.

Ans. The Otto engine employs the Beau de Rochas cycle in a single acting cylinder, occupying four consecutive piston strokes as follows:

1. First out-stroke drawing in the charge of air and gas.
2. First in-stroke compressing the charge.
3. Ignition at dead point with explosion of charge followed by second out-stroke and expansion of the hot gases.
4. Second in-stroke discharging the products of combustion from the space swept through by the piston, but not from the clearance space.

In this cycle, which is the one most commonly employed at the present day in small engines using illuminating gas, the third stroke is the only one during which work is done on the crank shaft, all three of the other strokes absorbing part of the power generated by the explosion and stored up in the fly-wheel during this single stroke.

The Otto engine is governed on what is known as the "hit or miss" principle, that is, either a full charge or no charge at all is taken into the cylinder and exploded, the governor working on the gas valve in such a way that no gas is admitted to the cylinder as long as the engine is running at its normal speed, the valve opening only when the number of revolutions falls below that for which the governor is set. Thus, when running on a light load, the engine may miss either every other explosion or two out of every three, or so on, according to the load. This method of governing by admitting charges of full size only, makes the degree of compression of every charge the same, and thus causes all the gas to be employed under the most economical conditions for any particular engine ; but it permits, in fact depends upon, comparatively wide variations in speed, and therefore is not satisfactory when close speed regulation is important.

The Westinghouse gas engine also employs the Beau de Rochas four-stroke cycle, but has always two cylinders, and in the larger examples three, the pistons working in which are connected to the same crank shaft, thus securing in the smaller sizes one working stroke to each revolution, and in the larger three working strokes to each two revolutions.

The speed is governed, not by the "hit or miss" method of doing away with the explosions entirely when the speed runs above the normal, but by regulating the amount of the explosive mixture admitted to the cylinder in each complete

cycle in a manner similar to that employed for governing steam engines. In this way an explosion is secured in each cylinder for each four strokes, but the force of the explosions is varied in accordance with the amount of work to be done. The ports of the valves regulating the admission of gas and air to the cylinder are so arranged that their areas can be adjusted to give a mixture containing the desired proportions of air and gas entirely apart from the action of the governor, which simply controls the length of stroke of these valves, so that varying quantities of a mixture containing always the same proportions of air and gas (so long as the adjustment spoken of above is unchanged) are admitted into the cylinder. This method of governing keeps the speed more uniform than the "hit or miss" method; but, since the volume of the charge is varied for each cycle, the amount of compression is also varied, and the engine is not always working at the most economical degree of compression. For this reason an engine so governed uses more gas per horse power per hour, other things being equal, than does one governed in the other way. However, when the work to be done calls for great uniformity of speed, the loss in economy may easily be more than counterbalanced by the closer speed regulation, especially when gas is cheap.

As originally made in small sizes, the Körting engine also employed the Beau de Rochas cycle in a single acting cylinder, the governing being done by varying the strength of the charges. As now made in large sizes, 500 H. P. and over, with especial reference to the use of blast-furnace gas, the Körting is a two-cycle double acting engine, with two explosions for every revolution. The two-cycle working in the main engine cylinder is secured by the use of two auxiliary pump cylinders, one being used for air and the other for gas. These two pump cylinders are in line, and their pistons are fastened on a common rod driven by a crank set at an angle of 110° in advance of the main crank of the engine. The connections between the pumps and the main cylinder are such that gas and air from the rear end of the pumps can pass only to the rear end of the cylinder and vice versa.

Considering the main piston as starting from the rear end of

the cylinder, it travels forward until it uncovers the exhaust ports, which are located in the middle of the cylinder and are unprovided with valves, being opened and closed by the main piston itself. As soon as these ports are uncovered the pressure in the rear of the cylinder falls to atmospheric, and the admission valve is opened slightly before the piston reaches the end of the forward stroke. During the latter part of the forward travel of the main piston the pump pistons have been travelling backwards. and air has been compressed into the air pressure pipe. The gas pump valves are so arranged that the gas is not compressed at as early a point in the stroke as is the air, and as the air pressure pipe and the gas pressure pipe both deliver into a common valve chamber, the opening from which into the cylinder is controlled by a single valve, the air which is being delivered at a higher pressure at the moment the admission valve opens forces back the gas, and at first only air enters the cylinder. The exhaust ports being still uncovered, this air first forces the products of combustion out of the cylinder, and then, as the ports are closed, is supposed to form a layer next to the piston, leaving at the back of the cylinder a mixture richer in gas than would be the case if gas were admitted from the first. As the pump piston travels back the gas becomes compressed in the rear end of the gas pump, and, the excess of pressure in the air pipe and the rear end of the air pump having been reduced by the escape of part of the air into the main cylinder at atmospheric pressure, both air and gas pass into the cylinder until the admission valve closes as the pump pistons reach the rear ends of the cylinders. The proper proportion between gas and air is secured by having the areas of the air and gas cylinders bear the desired relation to each other.

By the time the admission valve closes, the engine piston has travelled through almost half of its backward stroke. During the rest of this stroke the mixture of air and gas is compressed, and when the stroke is completed this mixture is ignited, and by its combustion forces the piston out on the forward stroke. An exactly similar set of operations occurs in the forward ends of the main cylinder and the pump cylinders, and is repeated at each end of the cylinders for each revolution.

The governing of the Körting engine is done by varying the strength of the charge, but in a different manner from that employed in the Westinghouse. In the latter the proportion between the amounts of air and gas is always the same no matter how small the charge. In the former the quantity of air admitted is not changed, the governor controlling only the quantity of gas used. This is done by changing the time at which compression begins in the gas pump and thus the time at which gas begins to enter the engine cylinder, the admission of gas being advanced or retarded as more or less power is required. During the time that the gas is entering the cylinder it is mixed with the chosen proportion of air and it is claimed that this mixture forms a layer at the end of the cylinder and is not diffused to any great extent through the air that is first admitted, and that thus certainty of ignition is secured even with small quantities of gas. The volume of air being the same for every charge the total volume of the charge and therefore the degree of compression does not vary as much as in the case of engines governed as is the Westinghouse. (Trustees.)

12. Should the lining in the generator of a carburetted water gas apparatus be made single or double? Give the reasons for your answer.

Ans. The lining in the generator of a carburetted water gas apparatus can be made of single courses of blocks having the desired thickness, except for that portion of the height extending from just below the level of the grate bars to a point four feet above these bars, or even five feet above, if the fuel used is such that clinker forms against the wall to an unusual height, where it should be made with inner and outer courses whose combined thickness, including that of the joint between them, is equal to that of the single courses used above and below.

Except at the place mentioned the lining is not subject to any considerable wear and should not have to be renewed more than once in four to five years. A single course of thick blocks can be made and put in place more cheaply than two courses of thinner blocks and therefore is to be preferred

where the wear and tear is inconsiderable. For a height of three feet or four feet above the grate, however, the inner surface of the lining is subjected to a great deal of wear, on account of the formation, during the operation of the apparatus, of hard clinker which adheres tightly to the wall of this portion of the generator and has to be cut away from it with heavy steel bars each time the fire is cleaned. Even when the greatest care is taken not to injure it, the wall is sure to suffer from this cutting in the course of no great length of time, and this part of the lining of the generator must be renewed at intervals of from one to two years. If it is made in a single course of blocks the whole of the lining within the clinker zone must be taken out and replaced at these times, while if made in two courses it is only necessary to renew the inner course. In any case the work must be done before the thickness of the whole lining is reduced to that of the outer course of the two, so that the intervals between renewals cannot be made any longer with a single lining and the extra cost of renewing a single lining as compared with that of renewing only the inner course of a double lining cannot be offset in this way. A double lining for this part of the generator is, therefore, more economical in the long run, even though it may cost slightly more at first.

If, as is sometimes the case, a double lining is used throughout, at least two courses of single lining should be put in immediately above the courses that require frequent renewing in order to hold up the inner courses of the wall above them while the work is under way. If these single courses are not provided it is necessary to support the upper part of the wall when re-lining and this adds to the length of time required to do the work of re-lining as well as to the cost of this work. (Trustees.)

First Series of Questions, 1903—Fifth Section—Practical Class—American Gas Light Association.

1. Give the meaning of the terms "run of mine," "$\frac{3}{4}$ inch," and "$1\frac{1}{2}$ inch" as applied to bituminous coal, and state, with your reasons for the statement, which class of coal gives the best carbonizing results.

2. Describe the putting into operation of a new bench of retorts with either a full depth or a half-depth regenerative setting, from the lighting of the fire to the putting in of the first charge, giving the precautions to be taken to prevent injury to the setting.

3. The dip pipe on the take-off from the superheater into the washbox of a double superheater carburetted water gas apparatus has an internal diameter of 10″ and an external diameter of $11\frac{1}{4}$″ and has a seal of 2″. The internal diameter of the washbox is 4′ 0″. The drain pipes from the scrubber and condenser are carried down below the surface of the liquor in the seal pot to a depth of 3′ 9″. Two sets are in operation. An obstruction occurs in the pipe taking the gas from the condensers while one set is making gas and the other is under blast. Will the gas show first at the scrubber and condenser seals, or at the top of the superheater of the latter set? Give the reasoning and calculations by which your answer is reached.

4. In a coal gas apparatus what is a "washer"? What is a "scrubber"?

5. What would you do with quicklime to prepare it for the purifiers?

6. What action takes place between "oxide of iron" and sulphuretted hydrogen in the purifier? What change occurs in the mass when exposed to the atmosphere, after use in the boxes? Give a general answer, and then give the chemistry of the operations as far as you can.

7. The inner section of a two-lift gas holder has a diameter of 87′ and a height of 20′, and the outer section has the same height and a diameter of 89′. The cup is 16″ deep. The

holder is contained in a brick tank 91′ in diameter and 21′ deep from water line to bottom. In the tank is a "cone" which has a height of 15′, a diameter of 30′ at the top and one of 81′ at the bottom. How many gallons of water will be required to fill the tank to the water line, and what will be the working capacity of the holder in cubic feet? Give your calculations.

8. What is a heat unit? What is the value of a British thermal unit and of a calorie?

9. How often, when, and in what manner would you inspect house piping to insure tightness? Give your reasons.

10. Give a description, illustrated with sketches, of a Welsbach gas burner, and state how you would adjust air and gas so as to get the greatest amount of light with the proper consumption.

11. What causes an atmospheric burner to "light back" and to what is due the odor given off when this occurs?

12. In what part of the masonry or brick work of a gas works would you use cement mortar instead of lime mortar, and why?

(Answers to these questions are due April 1, 1903.)

Answers to First Series of Questions, 1903—Fifth Section—Practical Class—American Gas Light Association.

Answers to all of these questions, except Nos. 3, 7, 8 and 11, have been published in previous volumes of the Proceedings and can be found there as follows:

No. 1, Vol. XVIII, page 132.
No. 2, Vol. XVIII, page 41.
No. 4, Vol. XIV, page 33.
No. 5, Vol. XIV, page 19.
No. 6, Vol. XVII, page 59.
No. 9, Vol. XIV, page 23.
No. 10, Vol. XVII, page 66.
No. 12, Vol. XVII, page 58.

The answers to Questions Nos. 3, 7, 8 and 11 are as follows:

3. The dip pipe on the take-off from the superheater into the washbox of a double superheater carburetted water gas apparatus has an internal diameter of 10″ and an external diameter of 11¼″ and has a seal of 2″. The internal diameter of the washbox is 4′ 0″. The drain pipes from the scrubber and condenser are carried down below the surface of the liquor in the seal pot to a depth of 3′ 9″. Two sets are in operation. An obstruction occurs in the pipe taking the gas from the condensers while one set is making gas and the other is under blast. Will the gas show first at the scrubber and condenser seals, or at the top of the superheater of the latter set? Give the reasoning and calculations by which your answer is reached.

Ans. The gas will show first at the opening through which it can pass with the least resistance, and it is therefore necessary to determine the resistance offered by the washbox to the backward passage of gas and compare it with that offered by the depth of seal on the drain pipes.

Before any gas can pass backward through the washbox, the level of the water in the portion outside of the dip pipe must be depressed below the lower edge of this pipe, the water displaced being forced into the dip pipe. The pressure required to depress the level outside and raise that inside will be equal to the height, above the lower edge of the dip pipe, to which the water will have risen in the dip and take-off pipe when the outside level is just even with this edge. This height will be equal to the height at which the water on the inside stands above the edge when the pressures are equal inside and out, plus the quotient obtained by dividing the volume of water that has to be forced from the outside to the inside by the area of the pipe. The above volume of water is equal to the area of the space in the washbox outside the dip pipe multiplied by the depth of the seal.

In the case given, as the diameter of the washbox is 4′ 0″ or 48″, and its area is 1809.6 square inches, while the outside diameter of the dip pipe is 11¼″ and its area is 99.4 square inches, the area of the space outside the pipe is 1809.6—99.4 = 1710.2 square inches. The depth of seal is two inches, and

therefore the volume of water to be displaced is $1710.2 \times 2 = 3420.4$ cubic inches. The internal diameter of the dip pipe is ten inches and the internal area 78.54 square inches, hence the displaced water will fill the dip pipe to a height of $\frac{3420.4}{78.54} = 43.5''$. The dip pipe being sealed to a depth of two inches, the water will stand in it to that height when the pressures inside and outside are equal, and, therefore, the total height to which the water will have to be raised on the inside, before the bottom edge of the pipe will be left uncovered on the outside, will be $43.5 + 2 = 45.5''$.

Since the drain pipes from the condenser and scrubber are sealed to a depth of $3' 9''$, or $45''$ only, gas will escape through them before it shows at the top of the superheater, and will escape through the latter opening only in case the blowing of the seal on the drain pipes does not afford sufficient relief to keep the pressure down to $45''$. (Trustees.)

7. The inner section of a two-lift gas holder has a diameter of $87'$ and a height of $20'$, and the outer section has the same height and a diameter of $89'$. The cup is $16''$ deep. The holder is contained in a brick tank $91'$ in diameter and $21'$ deep from water line to bottom. In the tank is a "cone" which has a height of $15'$, a diameter of $30'$ at the top and one of $81'$ at the bottom. How many gallons of water will be required to fill the tank to the water line and what will be the working capacity of the holder in cubic feet? Give your calculations.

Ans. The volume of the space in the holder tank which will be occupied by water is equal to the difference between the volume of a cylinder, having a diameter equal to that of the tank and a height equal to the height of the tank from the bottom up to the water line, and the volume of a frustrum of a cone of the dimensions of the "cone" in the tank. The volume of a cylinder is equal to the product obtained by multiplying the area of the base by the height. A circle $91'$ in diameter has an area of 6503.9 square feet. The distance from the bottom of the tank to the water line is $21'$, so the volume of the cylinder formed by the tank is $6503.9 \times 21 =$

136,581.9 cubic feet. The volume of a frustrum of a cone is equal to the product obtained by multiplying the sum of the areas of the two bases and of a mean proportional between these two bases by one-third the altitude. In this particular case the lower base of the cone has a diameter of 81′ and an area of 5,153 square feet, and the upper base has a diameter of 30′ and an area of 706.9 square feet. The mean proportional between these areas is therefore $\sqrt{706.9 \times 5153} = 1908.5$, and the sum of the two areas and this mean proportional is 7768.4 square feet. The altitude of the frustrum is 15′, hence the volume is $7768.4 \times 5 = 38,842$ cubic feet. To fill the tank to the water line will require $136,581.9 - 38,842 = 97,739.9$ cubic feet, or $97,739.9 \times 7.48 = 731,094$ gallons of water.

The working capacity of the holder will be equal to the volume of the cylindrical portion of the inner section, the gas in the space under the crown above this cylindrical portion not being available for use, plus the volume of that portion of the outer section that is not lapped by the inner section, nor required to be kept below the water level in order to avoid any danger of the gas blowing out from under the bottom curb. The cup being 16″ deep, and safety requiring that the bottom of the outer section should always be kept 12″ below the water level, the working height of the outer section will be 2′ 4″, or 2.33′ less than its total height. The total height being 20′, the working height is 17.67′. The diameter of the inner section being 87′, the volume is equal to 5944.7 (the area of a circle 87′ in diameter) $\times$ 20 = 118,894 cubic feet. The diameter of the outer section being 89′, the working volume of this section is equal to 6221.1 (the area of a circle 89′ in diameter) $\times$ 17.67 = 109,927 cubic feet. The working capacity of the holder is therefore 228,821 cubic feet. (Trustees.)

8. What is a heat unit? What is the value of a British thermal unit and of a calorie?

Ans. In order to be able to express different quantities of heat in comparable terms it is necessary to have some standard

or unit of quantity by which to measure these quantities. Such a standard or unit is called a heat unit.

The British thermal unit (B. T. U.), the heat unit most largely used by English-speaking nations, is the amount of heat required to raise the temperature of one avoirdupois pound of pure water one Fahrenheit degree from the temperature of maximum density of water, which is 39.1 degrees Fahrenheit. The variation in the quantity of heat necessary to raise the temperature of a pound of water one degree is so slight for any temperature between 32° and 212°, that in general the British thermal unit may be safely taken as the amount of heat necessary to raise the temperature of one pound avoirdupois of pure water one degree Fahrenheit. Thus, we may say that to raise the temperature of 30 pounds of water from 40° to 60° Fahrenheit requires 600 British thermal units ; for we have raised 30 pounds of water through 20° of temperature, and to raise 30 pounds of water one degree requires 30 British thermal units, and to raise the same quantity 20 degrees requires 20 times as much, or 600 British thermal units.

A calorie, the heat unit used in connection with the metric system of weights and measures, is the amount of heat required to raise the temperature of one kilogramme of water one degree centigrade from the temperature of water at its maximum density, or about 4° C. For the reason stated above, the calorie may, in ordinary work, be taken to be the amount of heat required to raise, by one degree centigrade, the temperature of a kilogramme of water at any temperature between 0° C. and 100° C. Since a kilogramme equals 2.204 pounds and a degree centigrade equals 1.8 degrees Fahrenheit, a calorie equals $2.204 \times 1.8 = 3.968$ B. T. U. (Trustees.)

11. What causes an atmospheric burner to "light back" and to what is due the odor given off when this occurs ?

Ans. An atmospheric burner "lights back" whenever the speed with which the mixture of air and gas travels through the tube is slower than that at which a flame can spread through the mixture. Anything which decreases the rate of flow of the mixture of air and gas, or which increases the speed at which the flame can spread, will, therefore, tend to produce lighting back.

Some of the causes of a slow speed of the air and gas mixture are a large tube area, the issuing of the gas from the gas orifice at a low velocity because of being under a low pressure, and any draught or concussion of the air that creates a pressure at the point of ignition. The rapidity with which the flame can be propagated back through the mixture depends upon the proportion in which air and gas are present, being greater the more nearly the amount of air present approaches to that required for the complete combustion of the gas. Lighting back may therefore be brought about by the gas being at too low a pressure, by a draught, or a sudden wave of air, such as that produced by the violent closing of a door, or by poor design in the burner, either in the way of providing too large a tube or of permitting the drawing in of too much air for the amount of gas used.

When lighting back occurs the gas burns as it issues from the gas orifice without being previously mixed with air, and consequently a luminous flame is produced. The conditions under which this flame burns are extremely unfavorable for the attainment of the complete combustion of the gas, because, not only is the access of air to the flame extremely restricted, but the flame is also surrounded by cold surfaces, and is extinguished by contact with them before complete combustion can take place. The combustion has, however, proceeded to a point at which the decomposition of the hydrocarbons has begun, and as one of the first steps in this decomposition is the formation of acetylene, C_2H_2, the products of the arrested combustion contain an appreciable percentage of acetylene, and it is to this gas that is due the distinctive odor noticed whenever an atmospheric flame is allowed to burn after having lighted back. The products of this arrested combustion also contain carbon monoxide and are therefore poisonous. (Trustees.)

FIRST SERIES OF QUESTIONS, 1903—FOURTH SECTION—PRACTICAL CLASS—AMERICAN GAS LIGHT ASSOCIATION.

1. When using gas oil as the carburetting material in a double superheater carburetted water gas apparatus, should the checker bricks be kept at the same temperature in both the carburetter and superheater? If not, in which vessel should the highest heat be carried? Give the reasons for your answer.

2. It is desired to "let down" a bench of coal gas retorts heated by a regenerative furnace. What is to be done in order that the bench may, with safety, be cooled down and kept idle until the increasing demand for gas, or other reason, shall make it important to again fire it up? No repairs are to be made to the bench.

3. Give a description, illustrated with sketches, of some form of furnace for horizontal tubular boilers adapted to give a good evaporation per pound of gas coke.

4. Give a drawing showing, by a section through the centre lines of the bent pipes, the layout for the bells on the mouthpieces and for the bent pipes for a bench containing six retorts, of the cross section given on the cut accompanying the answer to Question No. 2, Second Series, 1901, set in two vertical rows of three each, the centres of the retorts in each row being 2′ 2″ from the centre line of the bench and 2′ 0″ apart vertically. The pipes are to be 7″ in diameter. The hydraulic main is 9′ 6″ long over all and has a 3″ angle iron at each end, the space between these angles being 9′ 0″. The drawing must be fully dimensioned. Give also a written explanation of your reasons for adopting the design shown.

5. A boiler using a fuel with a calorific value of 14,000 B. T. U. per pound is shown by a test to be evaporating 8.9 pounds of water per pound of fuel used. The water is fed to the boiler at a temperature of 120° F. and the gauge pressure is 100 pounds. What is the efficiency of the boiler? Give your calculations.

6. Describe some method of making iron oxide to be used

for the removal of sulphuretted hydrogen from gas during its purification.

7. How would you make quantitative tests for carbonic acid and sulphuretted hydrogen in gas? How much by volume of each would you expect to find in coal gas and in carburetted water gas at the inlet to the purifiers?

8. If you had a set of purifiers consisting of four 10′ × 10′ × 4′ boxes in which you wished to use oxide of iron in one layer 3′ 0″ deep in each box, how many bushels of oxide would you buy, or make up? The amount given should include not only the oxide actually in the boxes at any one time, but also that which it would be necessary to have on the floor at the same time, to make it certain that each lot of oxide would be afforded the opportunity for complete revivification. Give the reasons for your answer.

9. How does the calorific value of gas affect the consumption per horse power in a gas engine, and what do you consider a fair average rate of consumption per brake horse power for a 10-horse engine using a gas having a net calorific value of 650 B. T. U. per cubic foot?

10. If you were sent to a house to investigate a complaint of "poor gas" how would you proceed to determine the cause of the trouble?

11. An instantaneous water heater burning gas at the rate of 81 cubic feet per hour will heat water from a temperature of 54° F. to one of 117° F. at the rate of 72 gallons per hour. The gas has a net calorific value of 650 B. T. U. per cubic foot. What is the efficiency of the heater?

12. Describe the proper method of laying brick in holder tank work.

(Answers to these questions are due May 1, 1903.)

Answers to First Series of Questions, 1903—Fourth Section—Practical Class—American Gas Light Association.

Answers to Questions Nos. 2, 6, 10 and 12 have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 2, Vol. XIV, page 41.
No. 6, Vol. XVIII, page 80.
No. 10, Vol. XVIII, page 35.
No. 12, Vol. XV, page 41.

The answers to the other questions are as follows:

1. When using gas oil as the carburetting material in a double superheater carburetted water gas apparatus, should the checker bricks be kept at the same temperature in both the carburetter and superheater? If not, in which vessel should the highest heat be carried? Give the reasons for your answer.

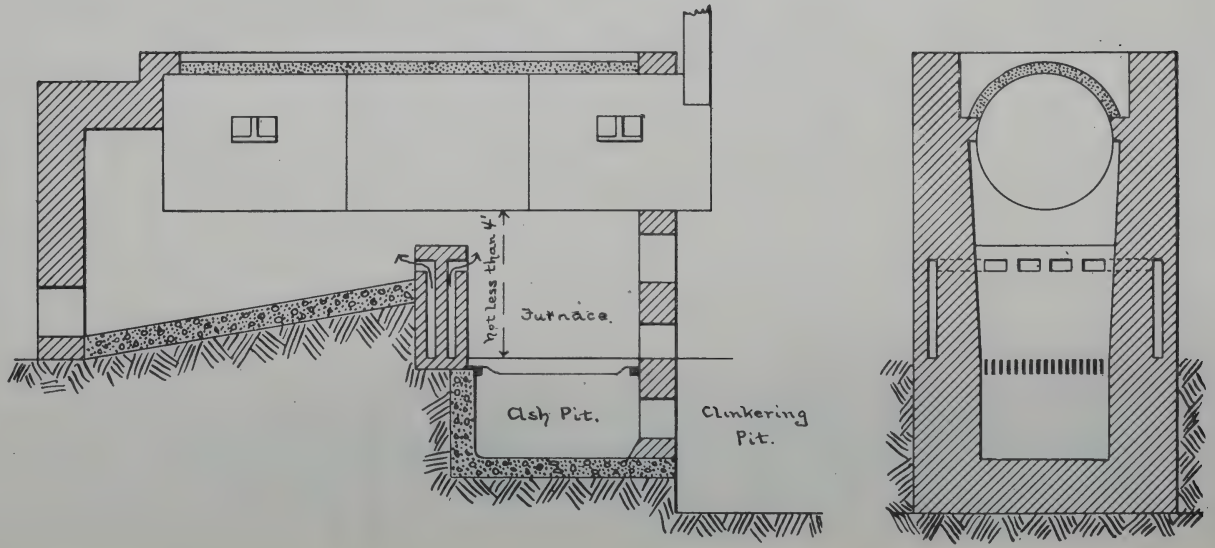
Ans. Under ordinary conditions, the best oil efficiencies are obtained by carrying the checker bricks in the carburetter at a higher heat than those in the superheater.

The reason for this is that a high initial heat seems to be required for evaporating the oil and breaking it up into permanent gases, while these gases, after their formation, should pass as soon as possible into a somewhat lower temperature, since the heavy hydrocarbons or illuminants will be deteriorated by further breaking down if they are subjected to too long an exposure to the high temperatures at which the oil is best broken up. (Trustees.)

3. Give a description, illustrated with sketches, of some form of furnace for horizontal tubular boilers adapted to give a good evaporation per pound of gas coke.

Ans. The boiler furnace illustrated on the accompanying cut is one that was designed and is used by a gas company which also operates the electric light and power plant in its city. When burning coke in the ordinary boiler furnace in the electric light plant it was found that a comparatively low

Deep Furnace for Boiler Burning Coke



evaporative efficiency was obtained from it, especially when the boilers were being worked at nearly their rated capacity. The reason for this seemed to be that, owing to the open character of a coke fire, a considerable excess of air was drawn through it when burned with the thin fuel bed customary in a boiler furnace, and that this excess of air reduced the efficiency by carrying a large amount of heat out of the chimney.

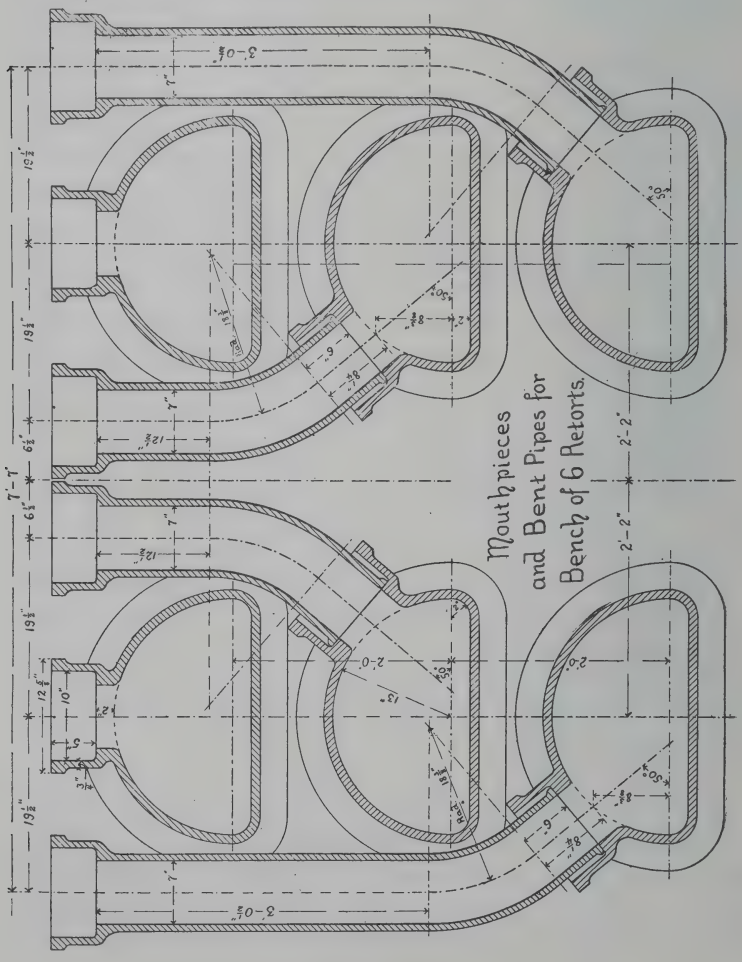
To avoid this effect, furnaces were constructed as shown on the cut. These furnaces are made much deeper than the ordinary ones, the distance from the grate bars to the bottom of the boiler being not less than four feet. It is thus practically a generator furnace. The primary air is admitted through the ash pit in the usual way and a supply of secondary air enters through two air ports, one in each side wall of the furnace just below the boiler front. Each port opens into a flue in the side wall which runs back to the bridge wall, and into two flues in this wall. From one of these the air escapes by openings to the front and from the other by openings to the back, as shown on the cut. The secondary air required is thus delivered, from both the front and the back of the bridge wall, to the gas produced in the deep fuel bed. The amount of secondary air admitted must, of course, be proportioned to the amount of gas being produced in the furnace.

While with the ordinary boiler furnace coke had been found to give evaporative results from 10% to 15% lower than those obtained from steam coal in the same boilers, when the furnaces described were used the evaporative efficiency of the coke was brought up to an amount equal to that of the coal. The work of firing with this furnace is stated to be easier than with the ordinary grate and steam coal. The repairs are small and the fire has to be clinkered only once in a day of twenty-four hours. (Trustees.)

4. Give a drawing showing, by a section through the centre lines of the bent pipes, the layout for the bells on the mouthpieces and for the bent pipes for a bench containing six retorts, of the cross section given on the cut accompanying the answer to Question No. 2, Second Series, 1901, set in two ver-

tical rows of three each, the centre of the retorts in each row being 2′ 2″ from the centre line of the bench and 2′ 0″ apart vertically. The pipes are to be 7″ in diameter. The hydraulic main is 9′ 6″ long over all and has a 3″ angle iron at each end, the space between these angles being 9′ 0″. The drawing must be fully dimensioned. Give also a written explanation of your reasons for adopting the design shown.

Ans. One of several possible ways of making the bells on the mouthpieces, and the bent pipes, for the bench of six



retorts described in the question is shown on the cut. The mouthpieces are designed to be the full size of the retort all through, this being very necessary for retorts that are to be drawn by machinery. The bells are made large so as to leave plenty of room for the joints around the spigot ends of the bent pipes, it being difficult to make these joints tight when the space left for them is too small. The curved portions of the bent pipes themselves are made with as large a radius as it is possible to have on the two which pass up in the space between the top mouthpieces. This radius being sufficiently large to give a good sweep, has also been adopted for the pipes passing outside of the top mouthpieces in order to have all the bends the same, and so save pattern work, even though here a longer radius could have been used. The part of each bent pipe which enters the bell has been made straight to make it easier to secure a good joint. The different bent pipes have been made of such lengths as to bring all the bells into which the stand-pipes enter, including those on the top retorts, on the same level, since this gives to the front of the bench a much neater appearance than it has when these bells are at different heights.

If wrought iron stand-pipes are to be used, the diameter of the bells on the top mouthpieces and bent pipes can be reduced a little, if desired, and for the sake of simplifying the construction and reducing the weight of the mouthpieces, some engineers make them without bells, providing instead seats to which the flanged ends of the bent pipes, or of short flanged bells for the top retorts, can be bolted. (Trustees.)

5. A boiler using a fuel with a calorific value of 14,000 B. T. U. per pound is shown by a test to be evaporating 8.9 pounds of water per pound of fuel used. The water is fed to the boiler at a temperature of 120° F. and the gauge pressure is 100 pounds. What is the efficiency of the boiler? Give your calculations.

Ans. From the steam tables it is found that the total heat above 32° F. in a pound of saturated steam at a gauge pressure of 100 lbs. is 1184.4 B. T. U. Since the water is fed into the boiler at a temperature of 120° F., it already possesses a

quantity of heat above 32° F. equal to 120 — 32 = 88 B. T. U., so that there is imparted to it in the boiler, to convert it into steam at a gauge pressure of 100 lbs., only 1184.4 — 88 = 1096.4 B. T. U. per lb. There being 8.9 lbs. of steam formed under the given conditions for each pound of coal used, the heat put into the steam, that is, the useful work done, per lb. of coal is 1096.4 × 8.9 = 9757.96 B. T. U. The combustion of the coal produces 14,000 B. T. U. per lb. Since only 9757.96 of these are used, the efficiency of the boiler is 9757.96 ÷ 14,000 = 69.7%. (Trustees.)

7. How would you make quantitative tests for carbonic acid and sulphuretted hydrogen in gas? How much by volume of each would you expect to find in coal gas and in carburetted water gas at the inlet to the purifiers?

Ans. "A rapid estimation of the carbonic acid in gas can be made as follows:

"The apparatus employed is shown on the cut. It consists of a water jacketed graduated burette provided at its lower end with a levelling bulb and communicating at its upper end with the gas supply and the absorption bulb by means of a three-way stop-cock.

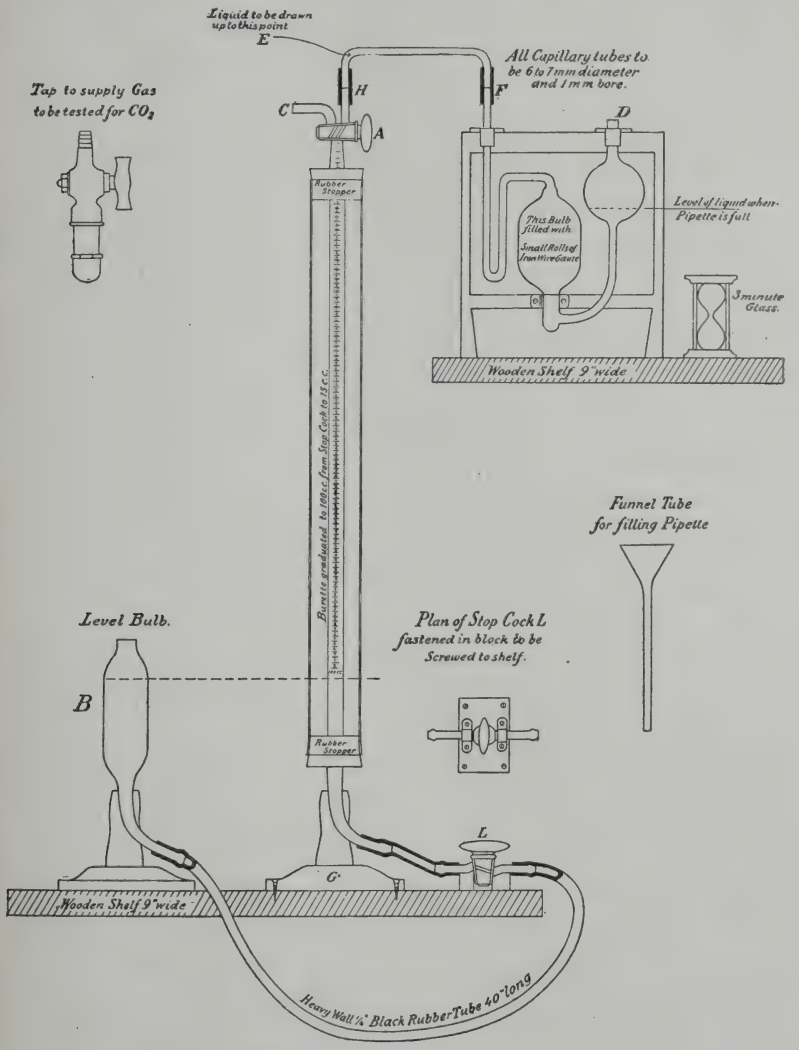
"It has a capacity of about 105 c. c. and is graduated in 1/5ths c. c. from the stop-cock down to the 100 c. c. mark. The burette is mounted on a solid iron base, which is screwed down to a shelf provided for the purpose close to the gas supply.

"The CO_2 is absorbed by a solution of caustic potash in a pipette filled with rolls of iron wire gauze, which presents a large surface to the gas. The iron stand holding the pipette is placed on a shelf at a proper height and is connected to the burette by means of a capillary tube with rubber connections. Before making a test, the gas must be freed from sulphuretted hydrogen by passing through an oxide purifier.

"To set up apparatus: Set lower shelf about 36 inches from floor. Screw base of burette, G, firmly to shelf, placing it about half way between wall and edge of shelf. Set upper shelf at such height that the top of capillary, F, on pipette will be level with top of capillary, H, on burette. Fill pipette

Apparatus

For rapid determination of Carbonic Acid in Gas.


Liquid to be drawn up to this point
E
All Capillary tubes to be 6 to 7 mm diameter and 1 m m bore.
Tap to supply Gas to be tested for CO_2
H
F
C
A
D
Rubber Stopper
This Bulb filled with Small Rolls of Iron Wire Gauze
Level of liquid when Pipette is full
3 minute Glass.
Wooden Shelf 9" wide
Burette graduated to 100 cc from Stop Cock to 15 c.c.
Funnel Tube for filling Pipette
Level Bulb.
Plan of Stop Cock L fastened in block to be Screwed to shelf.
B
Rubber Stopper
L
G
Wooden Shelf 9" wide
Heavy Wall 1/4" Black Rubber Tube 40" long

with potash solution as directed below, and connect parts of apparatus with rubber tubing as shown in drawing. Screw frame of pipette to the upper shelf.

"Loosen upper rubber stopper of water jacket and fill with clear water. Use distilled water if possible, as it will remain clear and free from annoying air bubbles.

"Saturate some clear water, preferably distilled, by allowing gas to bubble through, and with it fill level bulb, B, letting water run into burette as well.

"To prepare solution: Dissolve 1/4 lb. of caustic potash in a half pint of water, distilled if possible.

"To fill pipette: With capillary of pipette disconnected from connection at F, pour the solution through funnel tube into pipette at D, until the round bulb is about one-quarter full. Then connect pipette and draw the solution up into capillary as directed below. When the cylindrical bulb is completely filled, the round bulb should remain nearly empty.

"Refill the pipette with fresh solution about once in six months, and carefully note the date of filling on a tag attached to pipette.

"To perform analysis: Open lower stop-cock, L, and turn three-way stop-cock, A, so that burette is open to pipette, then by lowering level bulb, B, draw the potash solution up capillary tube to the point, E, just before capillary turns down, and close stop-cock, A. Leaving lower stop-cock open, turn stop-cock, A, till capillary, C, is open to burette, and then by raising level bulb, B, fill burette completely full of water. Close stop-cock, L. Now attach rubber tube to gas supply and allow gas to flow through tube for a moment to displace air; then with gas still flowing attach free end of tube to capillary, C. Open lower stop-cock, L, and draw in gas to the 100 c. c. mark. Close stop-cock, L, and then close stop-cock, A, and detach rubber tube. After three minutes bring the level of the liquid in burette exactly to 100 c. c. mark by raising or lowering level bulb, and close lower stop-cock, L. Open stop-cock, A, to capillary, C, for a moment in order to allow surplus gas to escape. There will now be exactly 100 c. c. of gas in burette, measured under atmospheric pressure. Now open stop-cock, A, to pipette and

force gas over into pipette by raising level bulb; draw gas back into burette immediately, letting the potash solution follow up capillary to point E as before, and close stop-cock, A. After three minutes, by raising or lowering level bulb, B, bring the water in burette and level bulb to the same level and close stop-cock, L. Note the point at which the water now stands in burette, and the difference between this reading and the original amount taken will be the CO_2 absorbed."

NOTE.—"See that the stop-cocks are kept well greased. If a stop-cock is found to be stuck, do not apply force to turn it. It may readily be loosened by warming the glass with a cloth dipped in hot water. When apparatus is not in use, the open ends of level bulb and pipette should be closed with corks." (*Adapted from Hempel's Gas Analysis.*)

"Sulphuretted hydrogen in crude gas can be determined quantitatively by a modification of the Harcourt color test. The test is based on the fact that when gas containing sulphuretted hydrogen is bubbled through a solution of a lead salt, the intensity of color imparted to the lead solution by the passage through it of a given quantity as compared with a standard tint corresponding to a definite quantity of lead sulphide, at once enables us to determine the amount of H_2S in the gas under examination.

"The manner of conducting a test is as follows:

"Lay a piece of white paper on the table, and fix a piece of cardboard upright in the brass clip provided for that purpose—the cardboard serves as a background against which to observe the color of the contents of the test glasses, and should receive a side light and be as clear as possible from shadows. Place the 'standard' glass, 'day light' or 'gas light,' according to circumstances, in its receptacle and dilute some of the concentrated lead syrup with twenty times its volume of distilled water, and fill one of the test glasses provided, up to the mark scratched on same, with a portion of the liquid thus prepared.

"Insert an india-rubber plug with capillary and elbow tubes, and connect up, as shown on cut, with the gas supply and aspirator, placing the standard glass and the test glass side by side on the white paper. The capillary tube should

descend very nearly to the bottom of the glass, but must not press on the bottom, or it will probably be broken. At starting, the aspirator should be full of water and the measuring cylinder empty. Turn the tap of the aspirator gradually, a stream of bubbles will rise through the lead solution. Turn off the tap for a minute, and observe the liquid at the bottom of the capillary tube. If it gradually rises, the india-rubber connections are not tight and must be made so before proceed-

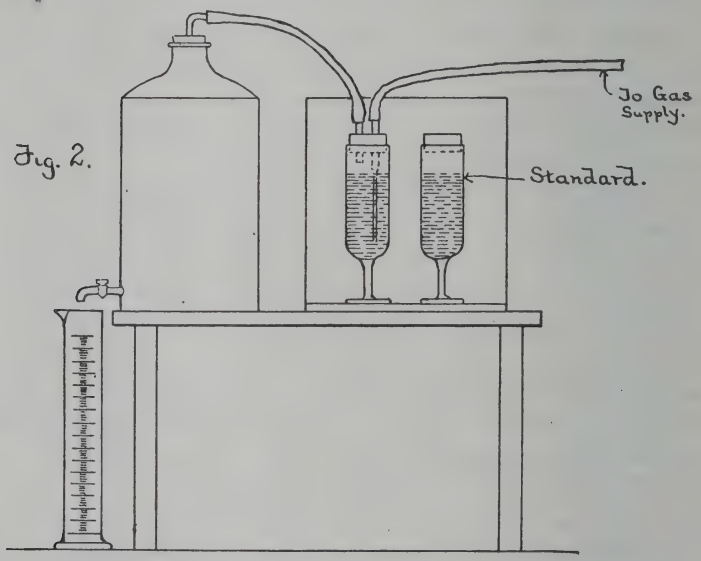


Fig. 2.

Test for Sulphuretted Hydrogen

ing any further. It is necessary to avoid pressing the plugs into the test glass or the aspirator while they are connected, which would drive up the lead solution into the inlet tube.

"When the connections are air-tight, allow the water to run into the measuring cylinder in a slender stream until the lead solution has become as dark as the standard. As the ascending bubbles interfere with the observation of the tint, it is best to turn off the tap when the color seems almost deep enough; compare the two, turn on the tap if necessary for a few minutes, then compare again, and so on, until the color of the two liquids is the same. The volume of water which

the measuring cylinder now contains is equal to the volume of gas which has passed through the lead solution. This volume of gas contained a quantity of sulphur as sulphuretted hydrogen, which, as lead sulphide, has colored the liquid in the test glass to the same depth as the standard tint. The standard has been made such, that to impart this tint to the solution of liquid contained in the glass, 0.0187 grains of lead sulphide must be present, containing 0.0025 grains of sulphur.

"For most tests for sulphuretted hydrogen on crude gas, a measuring cylinder containing 1/200 of a cubic foot and divided into 100 parts, is used. Each division represents $\frac{1}{20,000}$ of a cubic foot, and if the water from the aspirator in a test occupies x divisions, then $\frac{x}{20,000}$ cubic feet of gas contain sulphuretted hydrogen equivalent to 0.0025 grains of sulphur. Therefore, 100 cubic feet of gas contain $\frac{5,000}{x}$ grains of sulphur as sulphuretted hydrogen, since $\frac{x}{20,000}$: .0025 = 100 : number of grains of sulphur in 100 cu. ft. For gas containing less than 50 grains of sulphur per 100 cubic feet, a larger measuring cylinder should be used. One hundred grains of sulphur represents 106¼ grains of sulphuretted hydrogen." (*Hornby—Gas Engineers' Laboratory Handbook, and Butterfield—Gas Manufacture.*)

Another method of determining the amount of sulphuretted hydrogen in illuminating gas with a portable apparatus for the purpose is that devised by Mr. C. C. Tutwiler. "To describe the apparatus briefly, it consists of an absorption burette, provided with 3-way glass stop-cocks above and below, the upper one having a connection for the intake of gas and also connecting with a measuring tube surmounting it. This measuring tube is divided into c.c., which are again divided into tenths, holding altogether 10 c.c. of the iodine solution. This solution is carefully prepared so that each c.c. contains 0.0017076 grammes of iodine, which is calculated to absorb 100 grains of H_2S per 100 cubic feet of gas. In the lower part of the burette is admitted about 5 c.c. of

a starch solution made by dissolving one gramme of pure starch in 150 c.c. of water. After the burette has been filled in the usual manner with 100 c.c. of the gas to be tested, the iodine is trickled in drop by drop, with frequent shaking of the burette. As long as H_2S is present, the iodine is neutralized by it and does not affect the starch water, but as soon as all the H_2S present in the gas has been neutralized, any excess of the iodine will turn the formerly clear white starch water blue and the operation is then stopped. Readings of the scale on the measuring tube taken before and after the operation give the amount of iodine used to take out the H_2S, and a simple calculation will then give the number of grains of this impurity. If, for instance, we consumed 4.6 c.c. of the solution, we find that we had 4.6×100 or 460 grains of H_2S in 100 cubic feet. The possible error with careful manipulation is said not to exceed 10 grains."

The percentages of carbonic acid and sulphuretted hydrogen found in coal gas at the inlet to the purifiers will vary with the efficiency of the washing and scrubbing apparatus through which the gas passes before reaching this point, since the ammonia in the gas can, by proper treatment, be made to combine with a larger proportion of these impurities and remove them from the gas before it enters the purifiers. The percentage of sulphuretted hydrogen will also vary with the percentage of sulphur in the coal from which the gas is made.

Very little has been published in relation to the quantities of these impurities in coal gas made from American coals. In a paper read before the New England Association of Gas Engineers, Mr. Carroll Miller gave some figures which showed that the average amount of sulphuretted hydrogen at the inlet to the purifiers, in coal gas made from Pennsylvania gas coal, at the works under his charge, was about 446 grains per 100 cubic feet. This gas had been passed through rotary scrubbers of the standard type before going to the purifiers. Dr. E. G. Love has kindly given some figures he obtained in analyzing gas made from a mixture of Pittsburg, Fairmount and cannel coal. The gas at the inlet of the washer scrubber contained 918 grains of H_2S per 100 cubic feet, equal to 1.45%, and 785 grains of CO_2 per 100 cubic feet, equal to 0.97%. At the

outlet of the washer scrubber, that is, at the inlet to the purifiers, the figures were 254 grains, equal to 0.40% H_2S, and 693 grains, equal to 0.85% CO_2. The gas from coals containing more sulphur, such as most of the West Virginia coals, would, of course, contain more sulphuretted hydrogen. Butterfield gives the amount in well-washed gas made from Durham coal as 500 to 800 grains per 100 cubic feet, equal to from 0.79% to 1.26%. This coal contains from 2½ to 3 times as much sulphur as Pittsburg coal. According to the same authority, the carbonic acid will vary from 700 to 1100 grains per 100 cubic feet, equal to from 0.86% to 1.35%.

In the paper mentioned above, Mr. Miller gives the average amount of sulphuretted hydrogen in carburetted water gas made from gas coke and Pennsylvania oil as about 190 grains per 100 cubic feet of gas. As in coal gas, the percentage of this impurity will depend on the amount of the sulphur in the coal or coke used, and also upon the amount in the oil. Butterfield gives the figures for English practice as 0.15% to 0.25%. The percentage of carbonic acid will depend largely on the manner in which the apparatus is run and upon the fuel used, gas made from anthracite containing less than gas made from coke, other things being equal. The amount, assuming careful operation, may be taken as varying from 2.5% to 4.0%. (Trustees.)

8. If you had a set of purifiers consisting of four 10′ × 10′ × 4′ boxes in which you wished to use oxide of iron in one layer 3′ 0″ deep in each box, how many bushels of oxide would you buy or make up? The amount given should include not only the oxide actually in the boxes at any one time, but also that which it would be necessary to have on the floor at the same time, to make it certain that each lot of oxide would be afforded the opportunity for complete revivification. Give the reasons for your answer.

Ans. The volume of oxide of iron required to fill a purifying box 10′ square to a depth of 3′ 0″ will be 10 × 10 × 3 = 300 cu. ft. Purifying material being measured by the struck bushel, which contains 2,150 cubic inches, or 1.24 cubic feet,

300 cu. ft. will be $\frac{300}{1.24} = 241$ bushels, so that each batch of oxide will have to contain 241 bushels.

The number of batches that should be kept in use for a set of four boxes will depend somewhat upon the area of the space available for revivifying purposes. It is very important that the oxide should be fully revivified before it is put back into the purifying box, since if not so revivified it cannot do good work, and any attempt to get along with an insufficient number of batches leads to continuously deteriorating results. Therefore, when it is possible to secure the necessary area, it is best to keep in use eight batches, each box having its own two batches, which are used only in it. This allows each batch to remain on the revivifying floor at least four days, even when the conditions are so bad that it is necessary to change a box every day. If working under better conditions, there is still more time for revivification, and the oxide is in just that much better shape, since the longer it remains exposed to the air under favorable conditions the more certain it is to be thoroughly revivified.

If it is impossible to secure sufficient area to permit of handling the eight batches, seven, or even six, can be made to do, although the working will not be as satisfactory as with the larger number. But, even under this condition, a volume of oxide, equivalent to either one or two batches, should be kept on hand in addition to that in actual use, so as to be able to allow a batch that does not revivify in time to be used in its turn, to be set aside and replaced from the stock. It is, therefore, necessary in the case given, to buy, or make up, $8 \times 241 = 1{,}928$, or, say, 1,950 bushels of oxide. (Trustees.)

9. How does the calorific value of gas affect the consumption per horse power in a gas engine, and what do you consider a fair average rate of consumption per brake horse power for a 10-horse engine using a gas having a net calorific value of 650 B. T. U. per cubic foot?

Ans. A gas engine is a heat engine, that is, an engine in which energy in the form of heat is converted into mechanical energy, and, since a definite amount of heat is

required to produce any given amount of mechanical energy, it follows that the greater the calorific value of the gas used in a gas engine the smaller the amount required per hour per horse power developed. If the gas engine were capable of using, with the same efficiency, gases of any calorific value, the respective amounts of the different gases required per hour per horse power would vary inversely as their calorific values. It is found, however, that for various reasons gas engines work a little more efficiently when using gas of comparatively low calorific value, 150 to 300 B. T. U. per cubic foot, than they do when using gas of higher calorific value, 500 to 1,000 B. T. U. per cubic foot, so that they require somewhat less of the low value, in comparison with the higher value gas, than is called for by the relation between the calorific values.

In any case, the consumption of gas per horse power will vary with the condition in which the engine is kept and upon the proportion between the load it is carrying and that which it is capable of carrying, since when working at or near its full load the engine has a greater mechanical efficiency than when running under a small load. Under favorable conditions a 10-horse power gas engine can be run on a consumption of 20 cubic feet per brake horse power per hour when using gas of a calorific value of 650 B. T. U., but the average consumption under actual working conditions will be about 25 cubic feet per brake horse power per hour. (Trustees.)

11. An instantaneous water heater burning gas at the rate of 81 cubic feet per hour will heat water from a temperature of 54° F. to one of 117° F. at the rate of 72 gallons per hour. The gas has a net calorific value of 650 B. T. U. per cubic foot. What is the efficiency of the heater?

Ans. Under the conditions stated in the question the amount of heat developed in the heater per hour by the gas used is 81 (number of cubic feet of gas consumed per hour) × 650 (calorific value of a cubic foot) = 52,650 B T. U. The useful work done is measured by the amount of heat put into the water passing through the heater. The temperature of the water is raised 117 — 54 = 63° F. and the weight heated to this extent is 72 (number of gallons heated per hour) ×

8.33 (weight of a gallon of water in pounds) = 599.76 lbs. Therefore, the gas consumed does an amount of useful work equal to $599.76 \times 63 = 37{,}785$ B. T. U. and the efficiency of the heater is $\frac{37785}{52650} = 71.7\%$. (Trustees.)

SECOND SERIES OF QUESTIONS—SECTION OF 1906—PRACTICAL CLASS—AMERICAN GAS LIGHT ASSOCIATION.

1. What precautions should be taken to avoid spontaneous combustion in bituminous coal stored in a coal shed?

2. The furnaces employed for heating coal gas retorts may be divided into two general classes. What are these classes, what is the distinctive difference between them, and what advantages has either one over the other?

3. In the manufacture of carburetted water gas it is customary to have the water gas pick up the oil, in a state of vapor, at the entrance to the fixing vessels and carry this vapor and the resulting gas through these vessels, the oil gas being thus made in the presence of the water gas. What advantages has this method over that of making the oil gas entirely separate from the water gas?

4. Describe; with sketches if necessary, one or more forms of apparatus for removing heavy tar from gas, and state the position in the sequence of apparatus that should be occupied by the tar extractors, with your reason for such location.

5. Define the term Specific Gravity of a Gas. Give the limits between which you would expect the Specific Gravity of Coal Gas to vary. Same for Carburetted Water Gas. How do you account for the difference in Specific Gravity between the two gases?

6. Give the weight of a cubic foot of each of the following gases when dry and at a temperature of 60° F. and a pressure of 30″ of mercury:

Air	Hydrogen, H
Carbonic Acid, CO_2	Oxygen, O
Carbonic Oxide, CO	Nitrogen, N
Marsh Gas, CH_4	Ethane, C_2H_6
Ethylene or Olefiant Gas, C_2H_4	

7. Describe the ordinary qualitative tests for the presence in gas of Tar, Ammonia (NH_3), Carbonic Acid (CO_2), and Sulphuretted Hydrogen (H_2S), and state at what points in the apparatus the test for each should be made in order to determine that the gas is being properly purified. Give your reason in each case.

8. What is the meaning of "candle power" in the statement "this is a 20-candle power gas?"

9. Having provided drip pots at the proper points in the street main system what further precaution is necessary to prevent trouble from accumulation of condensation?

10. What principles govern the efficient combustion of gas for the production of light, and what details of construction have been adopted in the most improved forms of flat flame burners of the batswing or slit type to carry out these principles?

11. Why are Bunsen or Atmospheric burners used in gas cooking stoves and incandescent gas lights? Why are they not used in the ordinary cylindrical gas heating stoves and gas radiators?

12. What considerations would determine your choice between lime mortar and cement mortar for use in any given job of brick or stone masonry?

(Answers to these questions are due June 1st.)

Answers to the Second Series of Questions—Section of 1906—Practical Class—American Gas Light Association.

Answers to all of these questions, except Nos. 3, 7 and 12, have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 1, Vol. XIX, page 189.
No. 2, Vol. XVII, page 88.
No. 4, Vol. XVII, page 91.
No. 5, Vol. XVII, page 94.
No. 6, Vol. XIX, page 193.
No. 8, Vol. XVII, page 96.
No. 9, Vol. XVII, page 98.
No. 10, Vol. XVII, page 98.
No. 11, Vol. XVII, page 101.

The answers to Questions Nos. 3, 7 and 12 are as follows:

3. In the manufacture of carburetted water gas it is customary to have the water gas pick up the oil, in a state of vapor, at the entrance to the fixing vessels and carry this vapor and the resulting gas through these vessels, the oil gas being thus made in the presence of the water gas. What advantages has this method over that of making the oil gas entirely separate from the water gas?

Ans. The principal advantage that is thought to be obtained by carrying on the manufacture of carburetted water gas so that the oil gas portion is made in the presence of the water gas instead of being made entirely separate from the water gas, is that the presence of the water gas shields the oil gas from the heat and renders it less subject to over-decomposition in case the temperature of the heated surfaces is too high or the exposure to the heat too prolonged. The effect upon the oil vapors and gas of exposure to heat of too great intensity or for too long a time is to produce hydrocarbon gases of low illuminating values, or hydrocarbon vapors, which, although they are of high illuminating value, can be carried by the gas only to a limited extent. By separating and sur-

rounding the molecules of the oil vapors and gas, the water gas reduces the extent to which they are exposed to the heat and so reduces the liability to over-decomposition.

On the other hand, it is possible that an excess of water gas will exert so great an effect as to interfere with the complete gasification of the oil, and in cases where the amount of exposure is small or the intensity of the heat low, the presence of water gas during the decomposition of the oil may be detrimental. This, however, will not occur in an apparatus that is properly designed and handled.

Another advantage of making the oil gas in the presence of the water gas is that the latter will pick up and carry oil vapors that escape gasification, and, if the water gas were not present, would be condensed and left behind when the oil gas was cooled. These vapors are of value as illuminants, and so the candle power of the carburetted water gas made in this way will be higher for an equal amount of oil used than will be that of carburetted water gas made by making the water gas and oil gas separately and mixing them cold. This advantage can, however, be obtained to a great extent even when the two gases are made separately by mixing them hot.

This method of making carburetted water gas also makes it possible to conveniently arrange the apparatus so that the heat required for the gasification of the oil can be furnished very economically by the combustion, and partly by the sensible heat, of the producer gas formed in the generator while the fuel is being heated up to the temperature required for the manufacture of water gas. (Trustees.)

7. Describe the ordinary qualitative tests for the presence in gas of tar, ammonia (NH_3), carbonic acid (CO_2) and sulphuretted hydrogen (H_2S), and state at what points in the apparatus the test for each should be made in order to determine that the gas is being properly purified. Give your reason in each case.

Ans. The ordinary test for tar is made by allowing a jet of gas to impinge on a piece of white paper. If a dark stain appears on the paper, tar is present in the gas. A continuous test for tar can be made by passing a stream of gas through a

glass tube filled loosely with cotton wool. If tar is present in the gas, even if only to a very small extent, the cotton will be discolored.

The test for ammonia is ordinarily made by allowing a jet of gas to impinge on moistened turmeric paper, the turmeric paper turning brown if ammonia is present in the gas. Litmus paper, reddened by a weak acid, can be used instead of turmeric paper and will regain its original blue color if ammonia is present. The turmeric paper is more commonly used. Directions for preparing these papers can be found in Newbigging's Hand Book, 6th edition, page 292.

The test for carbonic acid is made by allowing a small stream of gas to bubble through lime water. If carbonic acid is present a white precipitate of carbonate of lime will be formed and the lime water will become cloudy, owing to the diffusion of this precipitate throughout the liquid.

The test for sulphuretted hydrogen is made by allowing a jet of gas to impinge on a piece of white paper wet with a solution of acetate (sugar) of lead. The formation of a dark stain indicates the presence of sulphuretted hydrogen in the gas.

Since the object of all these tests is to determine whether or not the gas is being properly purified, the test for each substance should be made at the outlet of that piece of apparatus which is employed to remove the last traces of such substance from the gas. The proper place at which to test for tar is, therefore, the outlet of either the tar extractor or the condenser, according to which piece of apparatus is being used for the purpose of removing the tar. The test for ammonia should be made at the outlet of the last scrubber or the last washer, since any ammonia that escapes absorption in these vessels is lost so far as any return from it is concerned. The test for carbonic acid and sulphuretted hydrogen should be made at that point in the series of purifiers at which it is desired that the purification should be complete. This is usually the outlet of the second box, if three boxes are in use, and the outlet of the third box when four are being used. (Trustees.)

12. What considerations would determine your choice between lime mortar and cement mortar for use in any given job of brick or stone masonry?

Ans. Since there are certain conditions under which lime mortar will not harden, and other conditions which are unfavorable to the durability of cement mortar, the main consideration in determining the choice between the two in any given case is that of the conditions to which the brickwork is to be subjected.

Lime mortar will not harden when cut off from access of air, or when exposed to water or to moist earth or air. It should, therefore, never be used in masonry work underground, in damp places and in thick walls, to the middle of which the air cannot penetrate, all such masonry being laid with cement mortar. Under the head of damp places must be included the top four or five courses of all brick walls, which should always be laid with cement mortar, even though lime mortar is employed for the rest of the work.

Cement mortar, on its part, will not be durable when exposed to even moderate heat, and so deprived of the moisture that is necessary to enable it to set and grow harder with age. It must, therefore, give place to lime mortar in that part of the brickwork of retort stacks, boiler settings and chimneys where it is not necessary to use fire clay on account of exposure to high heat.

When the conditions are such that either kind of mortar will set, the most important consideration in determining the choice between them is the strength that the masonry is required to have. Lime mortar is not as strong as cement mortar, and the latter must, therefore, be used whenever the strength requirements are greater than can be met by the former. It is also necessary to use cement mortar in masonry subject to vibration, such as the foundations of steam engines and other moving machinery, as in such masonry it is necessary to have the adhesion between the mortar and the brick or stone as strong as possible, and cement mortar is stronger in this respect than lime mortar.

Where lime mortar will set satisfactorily and is sufficiently

strong for the requirements, the consideration that usually determines the choice is cheapness, and as a rule lime mortar is the cheapest. But by properly proportioning the amount of sand used with cement, it is often possible to make a mortar that is as cheap as lime mortar, and stronger. The cement mortar can also be cheapened by mixing with it lime paste, and if the amount of this paste is not made greater than one-fourth of the combined amount of lime and cement, the resulting mortar will be stronger and better than lime mortar. But when there is not much difference between the cost of lime mortar and cement mortar without any admixture of lime, it is better to use the latter, since it is much more durable and will cost less for repairs. (Trustees.)

SECOND SERIES OF QUESTIONS, 1903—FIFTH SECTION—PRACTICAL CLASS—AMERICAN GAS LIGHT ASSOCIATION.

1. Is there any reason why gas coal that has been put into the coal shed of a gas works should not be left there indefinitely, if the supply is maintained so that it is not necessary to use it?

2. Describe the operation of a bench of coal gas retorts heated by a regenerative furnace, either half-depth or full-depth, including the care and operation of the furnace, standpipes and hydraulic main.

3. What is "coal liming?" Give its purpose and its effect on the impurities in the gas and on the residuals produced.

4. Give a description, illustrated by sketches, of the ordinary dry centre valve for four purifying boxes, built to put three in action at one time. Show on the sketches the divisions of the seat and cover, and describe the action of the valve.

5. Give a description, illustrated by sketches, of a "King's" pressure gauge.

6. Why is it important to have the water-line in the drum of a station-meter always at the same level?

7. What is the common method of manufacturing sulphate of ammonia, and what are the chemical reactions that occur in the process?

8. What are the products of the complete combustion of each of the following substances?

Carbon, C	Methane or Marsh Gas, CH_4
Carbonic Oxide, CO	Ethylene or Olefiant Gas, C_2H_4
Hydrogen, H	Ethane, C_2H_6
Benzene, C_6H_6	Acetylene, C_2H_2

Give in each case the weight of the products produced by the combustion of one pound of the substance.

9. Give the heating power, in British thermal units, of a pound, and in the case of gases also that of a cubic foot, of each of the substances named in Question No. 8, and tell what you understand this expression "heating power" to mean.

10. How should a gas works be situated with reference to the level of the district to be supplied?

11. Give the ordinary formula for the rate of flow of gas through pipes and calculate by means of this formula the amount of gas that can be delivered per hour through one-half mile of 6″ pipe with a loss of pressure of 5/10″, the specific gravity of the gas being 0.56.

12. Describe the proper method of laying bricks in cement mortar.

(Answers to these questions are due July 1, 1903.)

Answers to Second Series of Questions, 1903—Fifth Section—Practical Class—American Gas Light Association.

Answers to all of these questions, except Nos. 1, 8, 9 and 11, have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 2, Vol. XIII, page 43.
No. 3, Vol. XV, page 33.
No. 4, Vol. XV, page 30.
No. 5, Vol. XIV, page 35.
No. 6, Vol. XIV, page 32.
No. 7, Vol. XVII, page 85.
No. 10, Vol. XIV, page 25.
No. 12, Vol. XIX, page 65.

The anwers to Questions Nos. 1, 8, 9 and 11 are as follows:

1. Is there any reason why gas coal that has been put into the coal shed of a gas works should not be left there indefinitely, if the supply is maintained so that it is not necessary to use it?

Ans. For any given gas works the answer to this question depends upon the character and qualities of the coal used.

Some gas coals break up very badly when stored, the lumps becoming gradually converted into slack, and as this breaking up exposes fresh surfaces, as well as a greater surface in proportion to the volume, to the action of the air, and thus makes it easier for slow oxidation of the coal to take place, a comparatively rapid deterioration sets in and may continue until the value of the coal is practically destroyed. Under these conditions it is not advisable to keep coal in stock for any length of time, and a practice should be made of working out the oldest stock at regular and short intervals.

However, many of the gas coals used in this country, particularly those from Western Pennsylvania, do not depreciate to any great extent when stored, except on the surface of the pile, and even in this portion the loss is very small after the end of the first six months, so that such coal

when stored in fairly deep piles, protected from the weather, will suffer only a small total depreciation, the larger part of which takes place in the first year, even when stored for many years. When using coal of this kind, any stock that it is not necessary to use can be left in store indefinitely as far as loss in gas making value is concerned, since after having been stored for a year, the future depreciation on it will be much less than would be suffered by fresh coal stored in its place, and it is better to use the fresh coal, even if it is not possible to also make a saving in cost of handling by working the fresh coal directly into the retort house instead of having to put it into and take it out of the shed.

But even when the coal does not depreciate sufficiently to call for working out old stock, it is advisable to do this every few years and clean out the shed, for the purpose of checking the accuracy of the coal account as carried on the books, since in most coal sheds it is impossible to secure an accurate check in any other way. If, however, the coal is stored in pockets, into one of which a known quantity has been put and allowed to remain undisturbed, or if the stock pile is kept entirely separate from the rest of the coal and not drawn upon, there will be no reason for not keeping indefinitely a stock of coal of the character spoken of in the preceding paragraph, except an emergency when no other coal can be obtained. (Trustees.)

8. What are the products of the complete combustion of each of the following substances?

Carbon, C	Methane or Marsh Gas, CH_4
Carbonic Oxide, CO	Ethylene or Olefiant Gas, C_2H_4
Hydrogen, H	Ethane, C_2H_6
Benzene, C_6H_6	Acetylene, C_2H_2

Give in each case the weight of the products produced by the combustion of one pound of the substance.

Ans. The products of combustion of the various substances named when burned in oxygen, O, are,

Substance.	Products of Combustion.
Carbon.....C	Carbonic Acid, CO_2
Carbonic Oxide.....CO	" " "
Hydrogen.....H	Water Vapor, H_2O
Marsh Gas.....CH_4	Carbonic Acid, CO_2, and Water Vapor, H_2O
Olefiant Gas.....C_2H_4	
Ethane.....C_2H_6	
Benzene.....C_6H_6	
Acetylene.....C_2H_2	

When substances are burned in air it is usual to consider the nitrogen, N, which is mixed in the air with the oxygen used, as being also a product of the combustion. To the products as given above should, therefore, be added in each case this nitrogen.

The weights of the products produced are found as follows:

When carbon is burned, each atom combines with two atoms of oxygen, forming carbonic acid, CO_2. The atomic weight of carbon being 12 and that of oxygen being 16, the molecular weight of carbonic acid, each molecule of which contains one atom of carbon, C, and two atoms of oxygen, O, is $12 + 32 = 44$. Hence, 12 pounds of carbon will yield upon combustion 44 pounds of carbonic acid and 1 pound will yield $\frac{44}{12} = 3.67$ lbs. of carbonic acid. Since air contains 3.31 times as much nitrogen by weight as it does oxygen, the weight of nitrogen mixed in the air with the amount of oxygen, 2.67 lbs., required for the combustion of 1 lb. of carbon will be $2.67 \times 3.31 = 8.84$ lbs. The products of the combustion in air of 1 lb. of carbon are, therefore, 3.67 lbs. of carbonic acid and 8.84 lbs. of nitrogen.

The atomic weight of hydrogen is 1. Two atoms of hydrogen combine with one atom of oxygen to form a molecule of water vapor, the molecular weight of which is $2 + 16 = 18$. Two pounds of hydrogen thus yield upon combustion 18 lbs. of water vapor, and 1 lb. will yield 9 lbs. of water vapor. There will be mixed in the air with the amount of oxygen, 8 lbs., required for the combustion of 1 lb. of hydrogen, $8 \times 3.31 = 26.48$ lbs. nitrogen. The products of the combustion

in air of 1 lb. of hydrogen are, therefore, 9 lbs. of water vapor and 26.48 lbs. of nitrogen.

The combustion of marsh gas, or methane, CH_4, produces both carbonic acid and water. A molecule of marsh gas contains one atom of carbon and four of hydrogen and has a molecular weight of $12 + 4 \times 1 = 16$. In every 16 lbs. of marsh gas there will thus be 12 lbs. of carbon and 4 lbs. of hydrogen, or each pound will contain 0.75 lb. of carbon and 0.25 lb. of hydrogen. It has been shown above that each pound of hydrogen burns to 9 lbs. of water vapor, and that each pound of carbon burns to 3.67 lbs. of carbonic acid. Hence, the products of combustion of 1 lb. of marsh gas will be $0.75 \times 3.67 = 2.75$ lbs. of carbonic acid, $0.25 \times 9 = 2.25$ lbs. of water. The amount of the oxygen drawn from the air is $2 + 2 = 4$ lbs., so the weight of nitrogen to be included with these products will be $4 \times 3.31 = 13.24$ lbs.

The nature and weight of the products of combustion of the other hydrocarbons named can be determined in a similar manner to that employed above for marsh gas. For convenience, the results of these determinations, as well as those that have been worked out in detail, are given below in tabular form:

Name of Substance.	Weight of each Element in 1 lb. of Substance.			Weight of Products produced by the Combustion of 1 lb. of Substance, the Nitrogen mixed in air with the Oxygen required for combustion being considered as a product of combustion.		
	C	H	O	CO_2	H_2O	N
Carbon C	1.000			3.67		8.84
Carbonic Oxide, CO	0.429		0.571	1.57		1.89
Hydrogen ..... H		1.000			9.00	26.48
Marsh Gas... CH_4	0.750	0.250		2.75	2.25	13.24
Olefiant Gas, C_2H_4	0.857	0.143		3.14	1.29	11.35
Ethane ..... C_2H_6	0.800	0.200		2.94	1.80	12.38
Benzene .... C_6H_6	0.923	0.077		3.39	0.69	10.19
Acetylene... C_2H_2	0.923	0.077		3.39	0.69	10.19

(Trustees.)

9. Give the heating power, in British thermal units, of a pound, and in the case of gases also that of a cubic foot, of each of the substances named in Question No. 8, and tell what you understand this expression "heating power" to mean.

Ans.

	Per Pound.	Per Cubic Foot.
Carbon, C	14,647	
Carbonic Oxide, CO	4,383	325
Hydrogen, H	62,100	328
Benzene, C_6H_6	18,094	3,732
Methane or Marsh Gas, CH_4	24,017	1,016
Ethylene or Olefiant Gas, C_2H_4	21,898	1,621
Ethane, C_2H_6	22,338	1,772
Acetylene, C_2H_2	21,856	1,502

The figures given by different experimenters for the heating power of gases vary, as do the figures for the weights of a cubic foot of the gases, and, therefore, the figures for the heating power per cubic foot vary also. Thus Newbigging, quoting from Letheby, gives the following figures for the heating power per cubic foot:

H	329
CH_4	996
CO	320
C_2H_2	1,251
C_6H_6	3,860

and the Committee on Education, quoting from Julius Thomsen, gave for some of the same gases:

H	325.5
CH_4	1,022.8
CO	324.7
C_2H_2	1,493.4

The values first given above are based on the determination of calorific power made by Berthelot as given in Poole's "Calorific Power of Fuels," and the weight of gases calculated from the weight of air as determined by Regnault and afterwards corrected for slight errors.

By the calorific or heating value of a fuel is meant the total number of heat units that are developed by the complete oxidation of all the combustible materials contained in unit weight or unit volume of the fuel. In the case of gases, the calorific value is ordinarily expressed in heat units per cubic foot. In the case of liquids and solids, the heating value is expressed in heat units per pound.

In the case of hydrogen and substances which contain hydrogen as one of their constituents, a distinction must be made between the gross or total heating power and the net or available heating power. The complete combustion of such substances produces water, which, while it is liquid at ordinary atmospheric temperatures, is a vapor at the temperatures at which the products of combustion escape under the ordinary conditions of the combustion of gases. To convert a pound of water from the liquid state to that of vapor at 212° F., 966 heat units are required. Since each pound of hydrogen burns to 9 pounds of water, there will be a difference, for each pound of hydrogen contained in the combustible gas, of $9 \times 966 = 8{,}694$ heat units, plus the number of heat units given out by 9 pounds of water in cooling from a temperature of 212° F. to that at which the condensed water leaves the apparatus, between the total heat of combustion as measured by a calorimeter, in which the water is condensed to the liquid form and the heat required to vaporize it set free and measured, and the net heat or heat available, when, as in ordinary combustion, the water escapes in the form of vapor. If the temperature of the products of combustion is reduced to 60° F. by the calorimeter, the amount of heat given off by the water produced from one pound of hydrogen will be approximately $(212 - 60) \times 9 = 1{,}368$ heat units, and the difference between the gross and the net heating value of one pound of hydrogen will be $8{,}694 + 1{,}368 = 10{,}062$ heat units. If, therefore, the total heating power of hydrogen, as determined by the calorimeter, is 62,100 heat units, the net heating power, when the water escapes in the form of vapor at 212° F., will be $62{,}100 - 10{,}062 = 52{,}038$ heat units, and the net heating value per cubic foot will be 275 heat units. In the same way, knowing the percentage of hydrogen contained in

any substance, the net heating value can be obtained by making the proper deduction from the gross value.

The figures given above are in each case those for the gross or total heating power. The net heating powers, figured according to the example given, are given below. In figuring on problems in combustion, in which fuels containing hydrogen are used under working conditions, the net heating powers should always be employed to arrive at the true results.

	Per Pound.	Per Cubic Foot.
Hydrogen, H	52,038	275
Benzene, C_6H_6	17,322	3,572
Methane or Marsh Gas, CH_4	21,502	910
Ethylene or Olefiant Gas, C_2H_4	20,461	1,515
Ethane, C_2H_6	20,336	1,613
Acetylene, C_2H_2	21,081	1,448

(Trustees.)

11. Give the ordinary formula for the rate of flow of gas through pipes, and calculate by means of this formula the amount of gas that can be delivered per hour through one-half mile of 6″ pipe with a loss of pressure of 5/10″, the specific gravity of the gas being 0.56.

Ans. The ordinary formula for the rate of flow of gas through a pipe of any size under given conditions of length of pipe, specific gravity of gas and amount of pressure lost in the pipe is,

$$Q = 1350 \sqrt{\frac{d^5 p}{sl}}, \text{ or, as it is often written,}$$

$$Q = 1350 d^2 \sqrt{\frac{dp}{sl}}, \text{ in which}$$

Q = the volume of gas passed per hour in cubic feet,
d = the diameter of the pipe in inches,
p = the pressure or head in inches of water,
s = the specific gravity of the gas, air being 1.000,
l = the length of the pipe in yards, and

1350 is a constant, the value of which has been determined by experiment.

In the problem given, the value of the different factors are:

$d = 6$ $\quad$ $s = 0.56$

$p = 5/10$ $\quad$ $l = 880$

hence, substituting these values in the formula

$$Q = 1350 \times 36 \sqrt{\frac{6 \times 0.5}{0.56 \times 880}} = 48{,}600 \sqrt{\frac{3.0}{492.8}} =$$

$$48{,}600 \sqrt{.00609} = 48{,}600 \times .078 = 3{,}790 \text{ cubic feet.}$$

While it is necessary that the student should know the formula for the flow of gas and be able to apply it, in practice the results which have been obtained above by calculation can be obtained much more easily and quickly by the use of a gas-flow computer, which is a device of the slide-rule type, by means of which the size of pipe required to deliver any given quantity of gas under any given conditions of length of pipe, loss of pressure and specific gravity of gas can be read off by making the proper adjustments of the various scales marked on the computer. The use of one of these computers enables all problems similar to the one above to be rapidly and quickly solved. (Trustees.)

Second Series of Questions, 1903—Fourth Section—Practical Class—American Gas Light Association.

1. What are the advantages derived from heating the oil used in a carburetted water gas apparatus before it is admitted to the carburetter?

2. Give a drawing of one length of hydraulic main to be used with the bench of retorts illustrated in the Trustees' Answer to Question No. 4, First Series of 1903. This drawing should show all the dimensions of the main, and also the arrangements for running off the tar and ammoniacal liquor, and for cleaning the main, while in operation, from any heavy tar that may accumulate in it. State in writing the reasons that determine the choice of the dimensions that you give.

3. What points are to be observed in the design of a boiler setting in order to make it possible to obtain good efficiency of operation?

4. Name, in the order in which the gas should be subjected to them, beginning at the outlet of the hydraulic main, the various steps to be taken in the condensation and purification of coal gas, and state the temperature that should be possessed by the gas at the beginning and end of each step.

5. What is the meaning of the term horse power as applied to steam engines? What is indicated horse power? What is effective horse power?

6. Describe the proper treatment of iron oxide from the time it is taken out of the box for revivification until it is again returned to the box.

7. What is meant by the tension of a vapor? By maximum vapor tension?

8. Describe a system of records by means of which full information regarding the location, size, etc., of street mains can be economically filed in such shape as to be available for quick and ready reference.

9. What are the respective advantages of wet and dry meters for use as consumers' meters?

10. A complaint of a leak of gas is received from a consumer. Assume that it is your duty to investigate the complaint and tell how you would handle the job.

11. What relation, if any, is there between the calorific value of an illuminating gas and its illuminating value when consumed in a standard luminous flame burner?

12. Describe the method of building up the wall of a concrete gas holder tank and the precautions to be observed to insure its being water-tight.

(Answers to these questions are due August 10, 1903.)

Answers to Second Series of Questions, 1903—Fourth Section—Practical Class—American Gas Light Association.

Answers to Questions Nos. 5, 6 and 12 have been published in previous volumes of the Proceedings, and can be found there as follows :

No. 5, Vol. XVI, page 51.
No. 6, Vol. XVI, page 55.
No. 12, Vol. XVI, page 48.

The answers to the other questions are as follows :

1. What are the advantages derived from heating the oil used in a carburetted water gas apparatus before it is admitted to the carburetter?

Ans. The advantages derived from heating the oil used in carburetted water gas apparatus before it is admitted to the carburetter are a saving in coal, if the oil is heated by heat that would otherwise be wasted, and an increased efficiency in the use of oil.

All the oil run into the carburetter must be raised from the temperature at which it enters, to that existing in the carburetter, by means of heat supplied from the checker-brick, after having been received by them from the blast gases during the preceding blow. The lower the temperature at which the oil enters, the greater the quantity of heat that must be given out by and supplied to the checker-brick and, therefore, the greater the quantity of combustible blast gases required to be produced and the greater the consumption of coal in the generator. Any heating of the oil before it enters the carburetter thus causes a corresponding decrease in the amount of coal used in the generator, and if the otherwise waste heat in the gas leaving the apparatus is utilized for the purpose, the result is a clear gain in economy of fuel.

The work of heating, vaporizing and gasifying the oil lowers the temperature of the checker-brick in the carburetter and superheater continuously from the beginning to the end of a "run," and this cooling effect is naturally greatest at the

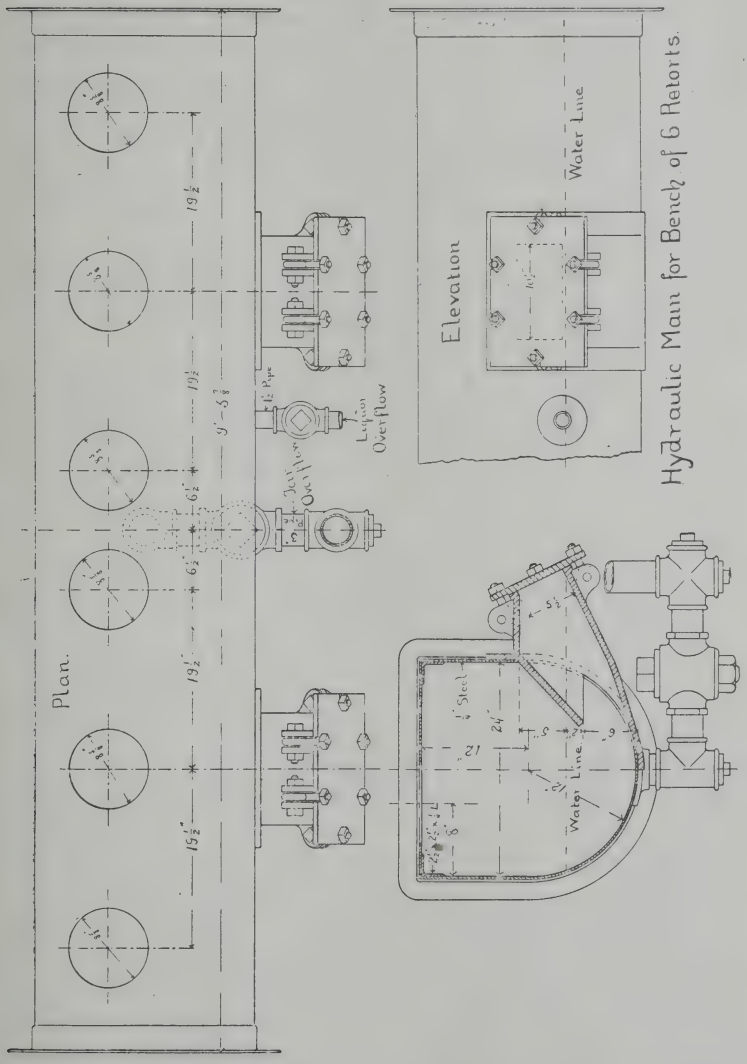
top of the carburetter where nearly all of the heating and evaporating of the oil is done. It is evident that, to obtain the best results, the temperature of the checker-brick should be kept throughout the run, as nearly as possible, constant and at the point best suited to the oil being used, and that any variation of the temperature from this point means a change in the conditions under which, and, consequently, probably a change in the efficiency with which, the oil is being gasified. Pre-heating the oil lessens this variation in temperature and therefore enables the oil to be gasified more efficiently. It would seem that when the oil is heated to a high temperature, the checker-brick in the carburetter and superheater should be kept at a lower temperature than when cold oil is used, in order to prevent the overheating and excessive breaking down of the heavy hydrocarbons derived from the oil.

It should be noted, however, that, on account of its partial vaporization, oil when heated to a high temperature is harder to spray evenly into the carburetter, and that, consequently, some engineers prefer to use the oil without pre-heating it. (Trustees.)

2. Give a drawing of one length of hydraulic main to be used with the bench of retorts illustrated in the Trustees' Answer to Question No. 4, First Series of 1903. This drawing should show all the dimensions of the main, and also the arrangements for running off the tar and ammoniacal liquor, and for cleaning the main, while in operation, from any heavy tar that may accumulate in it. State in writing the reasons that determine the choice of the dimensions that you give.

Ans. The accompanying cuts show a plan, section and part elevation of a length of hydraulic main made for the bench of retorts illustrated in the Trustees' Answer to Question No. 4, First Series of 1903, and also details of the liquor and tar overflows. The body of the main is made of $\frac{1}{4}''$ steel and the cleaning pockets of cast iron, these pockets being bolted or riveted to the body at the proper places. They are made, as shown, with their inner upper edges sealed below the liquor in the main, so that the covers can be taken

off at any time and the main cleaned without interfering with the operation of the retorts. The bottom of the pockets comes up on a gentle slope from the lowest point of the main, and



there is nothing to interfere with getting the heavy tar out very easily when it is necessary. The covers of the pockets

are fastened down by swinging bolts, and can be taken off and put back again very quickly and readily.

The liquor and tar overflows are made entirely of ordinary pipe and fittings, except that it is well to have the stop-cock on the tar-overflow made with the opening in the plug round and the full size of the pipe, which requirement is not fulfilled by the ordinary iron stop-cock. At the same time these overflows are adjustable over a height of 3″ or 4″. By setting a piece of plate glass in the outer horizontal outlet of the cross, into the bottom outlet of which is screwed the adjustable pipe, a means is afforded of observing the depth of the seal at all times.

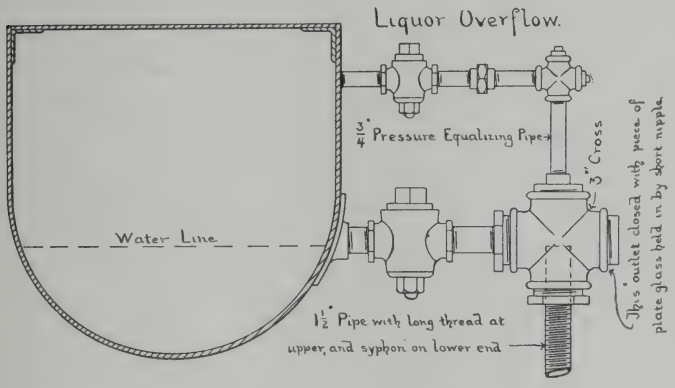
No gas take-off is shown. A short extension piece bolted on either end of the main, as may be most convenient, is provided for this.

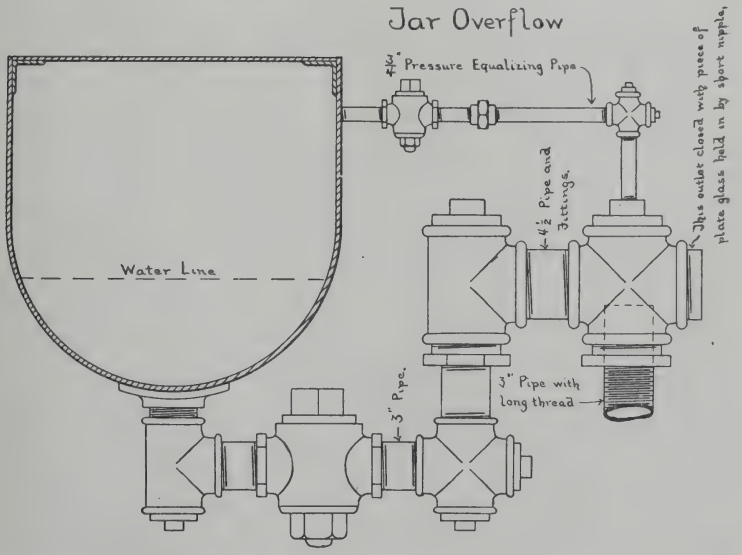
The reasons by which the general dimensions of the main are determined are as follows: The over-all length of each section must be just enough less than the distance between the middle lines of the partition walls of the bench, to allow for the thickness of the gasket required between two sections. The distance between the middle lines of walls being 9′ 6″ in the given case, the main is taken as 9′ 5⅞″ long. The width is determined by the area of liquor which it is required to have outside the dip pipes, and this depends upon the following considerations. It is necessary that the dip pipes should remain sealed when the retorts are open, and the surface of the liquor in the dip pipes is subjected to atmospheric pressure, even when the pressure in the main is at the highest point it is likely to attain under the conditions existing in any given works. The unsealing of the dip pipes, when the water is at the proper level, can only be brought about by the forcing up into them of a volume of water equal to the area of the liquor in the main outside of the pipes, multiplied by the distance from the normal surface of the liquor to the lower edges of the dip pipes, that is, of a volume equal to the surface area of the liquor multiplied by the normal depth of seal. The depth of seal is usually taken as 1″, and it is considered that the highest pressure that will have to be provided for will be 8″ to 9″. The width required

in the given case is therefore found by this calculation. Six dip pipes, having an internal diameter of 7″ and an external

Hydraulic Main.

Details of Liquor and Jar Overflows.


Liquor Overflow.
4½" Pressure Equalizing Pipe
3" Cross
This outlet closed with piece of plate glass held in by short nipple.
Water Line
1½" Pipe with long thread at upper, and syphon on lower end


Jar Overflow
4½" Pressure Equalizing Pipe
This outlet closed with piece of plate glass held in by short nipple.
4½" Pipe and Fittings.
Water Line
3" Pipe.
3" Pipe with long thread

diameter of 8¼″, will have a combined internal area of 291 square inches, and a combined external area of 321 square

inches. There being liquor to the depth of 1″ in the dip pipe under normal conditions, if the area of the main outside of the dip pipes is seven and a half times the total internal area, a pressure of 8.5″ will be provided for. The area outside the dip pipes must therefore be at least $7.5 \times 291 = 2183$ square inches, and the total area of the surface of the liquor should be $2183 + 321 = 2504$ square inches. As the length of the main is 9′ 6″ = 114″, its width at the water line must be $\frac{2504}{114} = 22''$. This width at the water line is secured by making the main 24″ wide and of the shape shown. If a greater pressure had to be provided for it would be necessary to make the main wider. By putting between each two lengths of main a partition extending 4″ or 5″ above the normal water line, and thus forming a separate water compartment for each bench, while leaving the gas-way open between the different lengths, the dip pipes on any bench that is idle can be given a heavier seal than those that are working, and thus be made safe against a higher pressure. (Trustees.)

3. What points are to be observed in the design of a boiler setting in order to make it possible to obtain good efficiency of operation?

Ans. The chief points in the design of a boiler setting which affect efficiency of operation are the area of grate surface, the size of combustion chamber, ease of getting at all parts of the heating surface for purposes of cleaning, and the prevention of loss of heat and of influx of air through the walls of the setting.

The proper area of grate surface depends upon the character of the fuel and the area of heating surface of the boiler. The grate must be large enough to burn the quantity of fuel required without the necessity for an excessive draft, but not so large in proportion to the heating surface that the products of combustion will, owing to contact with an insufficient amount of boiler surface, pass out to the chimney at too high a temperature. Knowing the amount of steam that the boiler will be required to furnish and the weight of water that can be evaporated by a pound of the fuel to be used, the

grate surface can be figured on the basis of a consumption of 10 lbs. of anthracite and 15 lbs. of bituminous coal per square foot per hour. This will give the largest area that will be required, which can be reduced, if found advisable, by bricking over part of the grate near the walls. The proportion between grate surface and heating surface should, according to Mr. Geo. H. Barrus, be as 1 to 36 with anthracite coal and as 1 to 45 to 50 with bituminous coal when the rate of combustion is from 10 to 12 lbs. of coal per square foot of grate surface per hour. If the rate of combustion is to be higher, there must be more heating surface in proportion to grate surface. The proportions given are those which were found in the boilers which showed the best efficiency out of a great number tested by Mr. Barrus.

The combustion chamber, that is, the space above the grate between it and the boiler, should be made large enough to enable the combustion to be completely finished before the products come in contact with the boiler. The temperature of the outside surface of the boiler shell is only a very little higher than that of the water in the boiler, and much below that required to carry on the combustion of the gaseous products of the partial combustion of the fuel, and therefore if these products come into contact with the boiler while still unconsumed, their temperature is reduced and combustion stops, with a consequent waste of fuel. As bituminous coal gives off more gaseous products that are combustible than either anthracite coal or coke, a larger combustion chamber is needed for the first than is required for the others. As the horizontal area of the combustion chamber is restricted by the size of the boiler, the increase in volume can only be obtained by an increase in the height, that is, the distance between the top of the fire and the lowest point of the boiler. With anthracite coal this height may be made as small as 18″, but with bituminous coal it must be made much greater, a height of four or five feet being required with coal giving off a large proportion of volatile matter. The necessity of providing sufficient room to enable the combustion to be fully completed before the products are cooled below the temperature of ignition is not always understood, but where this is not done the efficiency of the boiler suffers.

When the setting is not built so that all parts of the heating surface can be easily reached for cleaning, the parts that cannot be reached will soon become coated with soot and flue dust and rendered very inefficient.

To prevent loss of heat and influx of air through the walls of the setting, the outer walls should be made at least 24″ thick, with a 2″ air space in the middle of the wall, and where two or more boilers are set in a battery, each division wall should be in two parts with a half-inch space between them. This prevents radiation and also allows for expansion and contraction and thus reduces the liability of the walls to crack, a liability especially great in the case of a solid division wall with the boiler on one side let down while that on the other is under fire. The setting should also be well braced with buck-stays and tie-rods made strong enough for the work they are called upon to do. The part of the boiler above the setting should be covered with a plastic non-conducting material in a layer $2\frac{1}{2}$″ thick. Such a covering is a better non-conductor of heat and also lighter than the brick arch very generally employed, besides allowing greater freedom of access to the boiler in case of a leak. (Trustees.)

4. Name, in the order in which the gas should be subjected to them, beginning at the outlet of the hydraulic main, the various steps to be taken in the condensation and purification of coal gas, and state the temperature that should be possessed by the gas at the beginning and end of each step.

Ans. There is a difference of opinion among engineers as to the first step to be taken in the condensation and purification of coal gas as it leaves the hydraulic main. While there is no question that the heavy tar should be removed before the temperature of the gas has fallen below 100° F., it is claimed by some engineers that better and more uniform results are obtained from the tar extractor when gas reaches it at a uniform temperature between 110° and 120° F. than when its temperature is allowed to be above this, and they therefore advise a preliminary cooling, under control, for the gas, which leaves the hydraulic main at temperatures varying from 140° to 130° F., before it goes into the tar extractor. Other

engineers take the gas through the tar extractor with only such cooling as it gets in the pipe through which it passes, and some even go so far as to jacket this pipe to prevent any loss of heat. In most cases of recent construction the preliminary cooling has been adopted and is effected by the use of an annular atmospheric condenser, provided with means for regulating the amount of air flowing through the central opening and, consequently, the amount of cooling suffered by the gas.

As is implied by what is stated above, the next step is the removal of the heavy tar by some form of tar extractor which acts by friction and without affecting the temperature to any appreciable extent, and the gas should enter this piece of apparatus at a temperature not lower than 100° F. and leave it with a loss of not more than two or three degrees.

After passing through the hot tar extractor the gas is ready to be cooled gradually in water condensers by which its temperature should be reduced to 60° F. In cold climates there would not seem to be any objection to, and there might very possibly be an advantage in, cooling below this point, since the gas is certain to be cooled below it in the holders and street mains, and the gradual cooling that can be given in the condensers is less harmful than a sudden cooling later.

After being cooled, the next step is the removal of the ammonia by means of washers or scrubbers, or a combination of the two, the temperature being kept during this process at as near 60° as possible.

The final step in the purification of the gas is the removal of the sulphuretted hydrogen and, when advisable, of the carbonic acid contained in it. This removal can be effected most economically at a temperature of from 100° to 110° F. and the gas should be heated up to this point at the inlet to the purifiers. This heating can be done by steam either allowed to mix with the gas, or, preferably, passed through a coil of pipe in the bottom of the first box in the series.

As will be noticed no mention of the exhauster is made above, since it is not, strictly speaking, part of the condensing and purifying apparatus, all of which will work in exactly

the same manner and at the same temperature whether an exhauster is used or not. (Trustees.)

7. What is meant by the tension of a vapor? By maximum vapor tension?

Ans. By the tension of a vapor is meant the pressure exerted by the vapor against the walls of a vessel containing it or in opposition to any other restraining force. The pressure is due to the force with which the molecules of the vapor, as they move more or less freely along straight lines, strike against the walls of the vessel or move in a direction opposite to that of the force.

The tension of a vapor is also the measure of the extent to which it can resist compression, and the maximum vapor tension, sometimes called simply the vapor tension of a substance, is the heaviest pressure which it can resist, when in contact with some of the liquid from which it is produced, that is, when saturated, without a portion of the vapor being condensed back to the liquid form. For any given vapor this maximum tension varies with the temperature, being greater as the temperature is higher.

At the same temperature each vapor has its own maximum tension, the vapors of liquids boiling at low temperatures having greater tensions than those of liquids boiling at high temperatures. High "vapor tensions" therefore correspond to low boiling points, and, conversely, low "vapor tensions" to high boiling points. (Trustees.)

8. Describe a system of records by means of which full information regarding the location, size, etc., of street mains can be economically filed in such shape as to be available for quick and ready reference.

Ans. The question of street main records naturally divides itself into two parts, the obtaining of the data and the recording of them in a convenient accessible shape.

On new work the obtaining of the data is a very easy matter, although it is often overlooked. As each piece of main is laid, measurements showing the line on which it is run, its depth below the surface of the street, the location of all fittings, and

that of at least one bell on each block should be made and recorded. The measurements showing the line along which the main is run are generally taken from the nearest curb, but for unpaved streets it is probably preferable to take them from the property line, as this is less apt to change. The measurements along the line itself giving the location of fittings and of the bells, should be made from a zero point, such a point being adopted for each city block. One of the property lines of the intersecting street makes a good zero point, care being taken to take the corresponding line for each block along each street, and as far as possible for every one of a number of parallel streets, and to make all measurements in the same direction. Thus, on streets running north and south, the zero point should be either the south line or the north line of the intersecting street in each case, and not the south line in some cases and the north line in others. If no cut lengths are put in between intersections, except immediately at the fittings, it is only necessary to locate the bell at which the full lengths begin and to make a note of the normal distance between bells. If a cut piece is required away from a fitting, the bell at which the full lengths again begin should be located. This information as to the location of bells is valuable when the work of barring for leaks is to be undertaken, especially where the mains to be barred over are under pavement.

To make it easier to report the information noted above as being necessary, the person whose duty it is to obtain it should be provided with copies of a special form upon which it can be entered in writing as well as by means of sketches. Different forms are used by different companies, some using simply a card 5″ x 8″ on which a heading is printed as shown,

SKETCH CARD OF STREET MAIN CONNECTIONS.

.....Side.....Street

m.....To.....St.

.....Date.....19.....

mmenced.....19.....Finished.....19.....

and the remainder section-lined, that is, divided by light blue lines into squares, to make it easy to make sketches upon it;

while others use cards on which, in addition to the heading, is printed a diagram of a block with the two intersecting streets. The latter form does not meet the case of intersections at angles greater or less than a right angle. With either style of form one is filled out for each block of pipe laid and is used to post the information on the permanent record.

In the case of old work for which there are no records, every street opening made by the company, and all those made by others that are noticed, should be taken advantage of for the purpose of securing the information desired. For this purpose the foreman of every service gang and any other employees, including the superintendent, who are apt to come across such opening, should be equipped with small cards, printed as shown, on which to enter the measurements taken.

STREET MAIN INFORMATION CARD.

Nearest House No. _____ St

Nature of work _____ Date _____ 190

Size _____ Depth to top _____ Ft. _____ Ins. _____

Distance _____ Ft. _____ Ins. _____ of _____ Line

Drips towards _____

Kind of soil _____

Remarks _____

_____

_____

_____

Sign here _____

If an intersection is exposed a sketch can be made on the back of the card. Information as to drips and valves can be put as secured on other cards, printed as shown, and, if desired, sketches of connections to them can be made on the back of the cards. These drip and valve cards should also be used to report the location of drips and valves put in during the course of new work.

DRIP RECORD

Nearest House No._____ St.

_____ Date_____ 190

Location_____ Feet_____ Ins._____ of_____ Line

_____ Ft._____ Ins._____ of_____ Line of_____ St.

SIZE OF MAIN_____ Depth to Top_____ Ft._____ Ins._____

_____ Ft._____ Ins._____ of_____ Line_____

Style of Drip_____

Remarks_____

_____

_____

Signed_____

VALVE RECORD

Nearest House No._____ St.

_____ Date_____ 190

Location_____ Feet_____ Ins._____ of_____ Line

_____ Ft._____ Ins._____ of_____ Line of_____ St.

SIZE OF MAIN_____ Depth to Top_____ Ft._____ Ins _____

_____ Ft._____ Ins._____ of_____ Line_____

Kind of Valve_____

Opens to the _____

Remarks_____

_____

_____

Signed_____

When these cards are handed in, either to the record department in the case of a large company, or to the superintendent where the company is so small that this official is also

the draughtsman, the information contained in them should be posted to the street main maps and the cards then filed for future reference. The filing is often done according to geographical location, the streets being arranged alphabetically, and the cards for each street in the order of the street numbers. It may also be done by giving a number to every city block or every section of road in the territory, these numbers being marked on a wall map used as an index map, and filing all cards referring to any city block or section of road under the proper number, sub-numbers being used when two or more cards are filed for any block. Thus, if the block were No. 100, the first card would be No. 100–1, the second No. 100–2, and so on. When information is wanted for any locality, the number is found from the index map and it is very easy to find the card in the file. For comparatively small new systems and where the street numbers do not run by blocks, and, consequently, do not afford any indication of the exact location on the street of any number, or where there are no street numbers, as in small towns and along country roads, the block number system is the best. For very large old systems with no records there is not much choice, and the geographical filing does not involve any preliminary work in assigning block numbers.

A map showing the whole territory on one sheet, if possible, and on not more than two or three sheets at the outside, should be made on tracing cloth. A good scale for this map is 300 feet to the inch. If the blocks are to be numbered, the numbering should be done on this tracing. Except for the names of the streets and the block numbers, all of which should be put inside the property lines and not in the spaces showing the streets, the tracing is to be left unmarked and black on white prints are to be made from it for use as maps. On one such print every street main in the system should be entered, the different sizes being distinguished either by the use of different colored inks, or of different combinations of dots and dashes in the same color. When using different colors it is well to work from lighter to darker colors as the size increases, so that when an old main is replaced by a larger one, the darker color will cover the lighter one without any

need of making an erasure. This map will merely show the fact that at a certain location there is or is not a gas main, and, if the main is there, will give its size, but it will not show any details of location or construction. If desired, similar maps can be made to show trunk mains, nothing smaller than 8-inch being put on, and the general location of drips and syphons and valves, a separate map being used for each special purpose.

For recording details an "insurance map" of the territory should be bought whenever one is available. These maps show all settled parts of a city on a scale of 50 feet to the inch and the unsettled portions on a scale of 100 feet to the inch, and consist of a number of separate sheets bound in book form, each sheet covering several squares. On them are shown all buildings, and when they are purchased from the company that publishes them, arrangements can be made to have them kept posted as to new buildings and changes in old buildings. They sometimes also show water mains, and in ordering them it should be stipulated that water mains are not to be shown on the set furnished. If no insurance map or other already prepared large scale map be available, a special large scale map in sheets will have to be made to take its place. On whichever is used should be shown the size and detail of every street main. The sizes may be marked in the same way as on the small scale map, or all the mains may be put in in solid black lines and the size indicated by figures and the use of lines of different thicknesses. The distance of the pipe from the property line and the position of all fittings, drips, valves, sleeves, etc., should be located by writing on the map the proper dimension lines, the scale being large enough to permit this to be done with clearness in the case of all distribution systems, except those in a few of the very large cities where the underground situation is such as to make it necessary to use a large number of fittings, closely spaced. Rubber stamps of the proper shapes can be used for marking the various fittings to facilitate the work. With cards made out and filed and maps drawn as described above, there will be no trouble in finding quickly and easily any information as to the street main system that is desired, and the

information will have been obtained and filed as economically as it is possible to do it.

Articles which contain good ideas on the subject of street main records and maps will be found as follows: American Gas Light Journal, Vol. LXVI, page 481; Vol. LXX, page 482; Vol. LXXIV, page 449, and P. A., Vol. XVII, page 128; Vol. XIX, page 114.

9. What are the respective advantages of wet and dry meters for use as consumers' meters?

Ans. The principal advantages of well-made wet meters for use as consumers' meters are the accuracy with which they register the volume of gas passing through them and their simplicity of construction, by reason of which they are able to maintain this accuracy of registration over long periods of time without the necessity of being brought into the shop for repairs.

When made with a compensating device, which will, within limits, automatically keep the water line correct in spite of the evaporation of the water in the body of the meter, and with an anti-tilting valve which will shut off the gas in case an attempt is made to tilt the meter in order to cause it to pass gas without registration, a wet meter will measure with great accuracy the gas delivered through it, and as there are no diaphragms or slide valves to get out of order, by drying out or by friction, it does not require the periodical testing that is necessary to make certain that a dry meter is measuring correctly. On the other hand, the wet meter requires more frequent visits by the employees of the gas company, in order to maintain a sufficient quantity of water in the meter and to see that it is properly levelled.

The great advantage of dry meters as compared with wet meters for use as above is their freedom from the danger of freezing, to which wet meters are liable in cold climates. A second advantage derived from the absence of water is the reduced danger of the collection of water in any trapped places in the house-piping, with the consequent greater freedom from the jumping or complete shutting-off of the lights on the far side of such places.

Other advantages of dry meters are smaller first cost; greater ease of setting on account of their lighter weight, size for size, and of their not requiring to be so accurately levelled; greater ease of removing on account of their lighter weight, and of the freedom from the difficulty of disposing of the gas-saturated water which is experienced with wet meters; freedom from risk of the nuisance which may occur through escape of gas, and possibly the spilling of water saturated with gas, when the water in wet meters is replenished, and, consequently, the possibility of being put in places where wet meters would not be wanted by consumers.

In a general way, the advantage of the wet meter is, that it will, with moderate attention, which does not require the meter's removal from its position, continue for a long space of time to measure gas accurately, and the advantages of the dry meter are its cheapness in first cost, its freedom from freezing, and its convenience, in spite of the fact that it requires periodical removal for testing and repairs. The choice between them is determined mainly by comparing the cost of maintaining a high average of accurate registration with the two types. In cold climates, the freezing of the water in wet meters increases so greatly the convenience of dry meters as to make the use of the latter more economical; but in warm climates it may easily happen that the use of wet meters will be more economical than that of dry meters. (Trustees.)

10. A complaint of a leak of gas is received from a consumer. Assume that it is your duty to investigate the complaint and tell how you would handle the job.

Ans. The person investigating a complaint of a leak of gas should, after reaching the house and making known his identity and errand, obtain from the occupants all the information possible as to the size and location of the leak. If they can give definite information it can be acted upon; but, failing such information, a thorough examination of all the fixtures and piping will be required.

When the leak is noticeable in one room only, the keys of the fixtures in that room should be examined to see that all are shut off and that there are no leaks around them. Finding

the keys tight, the joints between different parts of the fixtures and between these and the pipe outlets should next be investigated. In every case the examination should be made by smelling at the suspected points, or, in case the sense of smell is deficient, by means of soapy water. In no case should a light be used, as it is dangerous. Moreover, even very small leaks can be located by smelling or by soapy water more quickly and accurately than by the use of a light. Never strike a match or attempt to light a leak after it has been found.

Where the smell of gas is noticeable more or less all over any one floor, the leak cannot be above this floor, and should be sought below it. In such a case it is well to start the search in the cellar, examining the end of the service, the meter and its connections, and all exposed piping, and, failing to find in any of these a leak sufficient to produce the smell noticed, the points at which the water pipe and sewer enter the cellar, and also any open joints in the masonry of the walls through which gas might be coming in from a leak outside the house. If gas is found to be coming in from outside, steps should be at once taken to have the leak located and stopped. The nearest telephone should be used for communicating with the office if necessary. If no clue is found in the cellar, the examination should be continued on the floors above until the leak is found or until all the fixtures and exposed pipes have been gone over. If the leak cannot be located on the premises, investigations should be made of the adjoining properties and the search continued until the leak is found.

When no leak can be located in the exposed work, its location in the concealed piping can often be closely approximated by smelling at the openings around sliding doors and along the baseboards.

Having located the leak, if it is inside the house, it is well to determine the rate of leakage by means of the test hand on the meter, it having been made certain that no gas is being used at the time. This done, the leak, if it can be gotten at and is such that it cannot be immediately repaired permanently, should be stopped temporarily with soap. If it is around the service, meter or meter connections, the consumer

should be told that it has been stopped temporarily and that the company will have it fixed permanently as soon as possible. This should also be done for a leak in a fixture or in exposed house-piping when the gas company does such work, otherwise the consumer should be told that it is necessary for him to have a gas-fitter attend to it.

If the leak is in the house and is bad but cannot be located, or if located cannot be gotten at, the gas should be shut off at the curb cock, when there is one, or else at the meter. The fact that the gas has been shut off should be at once communicated to the office, using telephone if necessary, so that an official letter can be sent to the consumer explaining why the gas is off and what the consumer must do to get the gas turned on again. If the leak is outside the house and is bad, the cellar windows, and if necessary the first floor windows as well, should be opened for ventilation, and the consumer instructed to keep them open and avoid the use of lights until the leak has been found and repaired. When the leak is small the gas need not be shut off in case of inability to locate and repair it, but the consumer should be instructed to get a gas-fitter to attend to it or told that the company will take further steps to stop it, as the case may be. Such steps would probably include the use of an air pump and ether to locate the leak and the opening of the floor or wall to afford access to it.

If, on calling to investigate a leak, it is found impossible to gain access to the premises and there is an odor of gas coming from the key-holes, window joints, etc., the gas should be immediately turned off at the curb cock, if there is one, and, if the house is apparently occupied, the police authorities notified. If unoccupied, access should be gained to the premises by securing the keys from the custodian. In either case, the office should be notified at once, by telephone if necessary.

If a leak is found to be dangerously bad, street help should be secured at once from the office. The occupants of all the premises in which the gas may be finding its way should be notified, and the houses ventilated.

If, when answering a complaint, a careful search reveals no leak, the occupants should be questioned further. Occasion-

ally the statement is made that the odor of gas is noticed at a particular time of day, or a certain condition of the weather. An appointment should be made to call at such a time in order that the consumer may be completely satisfied.

When an escape of gas has caused sickness, or an explosion or fire has occurred, the office should be notified at once, using the telephone if necessary. (Trustees.)

11. What relation, if any, is there between the calorific value of an illuminating gas and its illuminating value when consumed in a standard luminous flame burner?

Ans. There is no definite relation between the calorific value of an illuminating gas and its illuminating value when consumed in a luminous flame burner. The greater part of the calorific value is derived from components which do not of themselves furnish illuminating value, and by reason of change in composition it is possible for an illuminating gas to vary considerably in calorific value and yet be of the same illuminating value or to vary in illuminating power while remaining of practically the same heating value.

In the case of different samples of coal gas made from the same coal, but of different candle-powers by reason of being produced by carbonization of the coal at different temperatures, there is a fairly constant proportion between the illuminating value and the calorific value, as there is also, within certain limits of candle-power, in the case of different samples of carburetted water gas made from the same oil, but this relation does not hold between gases made from different coals or different kinds of oil.

In a lecture delivered before the Institution of Gas Engineers, Prof. V. B. Lewes gave the following table as the average relation between candle power and calorific value as determined by a number of tests, but said that the results in any particular case might vary 5 per cent. either way from these, and even with this qualification exception was taken to the figures by some gas engineers. They stand, however, as the most definite statement yet published.

Candle Power.	Calorific Value B. T. U.'s Per Cubic Foot.			
	Coal Gas.		Carburetted Water Gas.	
	Gross	Net	Gross	Net
12	540	480	490	452
13	560	500	510	472
14	585	522	529	489
15	610	542	547	508
16	625	562	567	527
17	647	582	587	547
18	670	603	607	567
19	690	622	627	587
20	712	642	647	607

(Trustees.)

THIRD SERIES OF QUESTIONS—SECTION OF 1906—PRACTICAL CLASS—AMERICAN GAS LIGHT ASSOCIATION.

1. To what state of physical subdivision is it advisable to reduce gas coal before charging it into the retorts in order to secure the best possible results as to yield of gas per pound of coal and per retort? Give the reasons for your answer.

2. Describe, with sketches, a generator furnace, either full depth or half depth, as applied to the heating of coal gas retorts. Pay particular attention to the points at which the primary and secondary air supplies are admitted, and the arrangements for filling the furnace, cleaning the fire and providing the steam required to keep the clinker soft, and do not omit sketches.

3. Describe, with sketch showing a vertical section of the apparatus, the construction of a double superheater Lowe carburetted water gas apparatus, and give a brief description of its operation for the manufacture of carburetted water gas.

4. Describe two forms of positive rotary exhausters commonly employed to draw gas from the retorts, or relief holder, and force it through the rest of the apparatus.

5. Using the weights per cubic foot of the various gases given in the answer to Question No. 6, Second Series, and the definition of specific gravity given in the answer to Question No. 5, Second Series, calculate (1) the weight of 1,000 cubic feet of coal gas with a specific gravity of .420; (2) the weight of 1,000 cubic feet of water gas with a specific gravity of .650; (3) the specific gravity of hydrogen (H), and (4) the specific gravity of carbonic acid (CO_2). Give your calculations in each case.

6. In a gas pipe, one end of which is higher than the other, such as the riser pipe in a house or a street main running up hill, and in which there is no flow of gas for the time being, the pressure, as shown by a syphon pressure gauge, will not be the same at the top and at the bottom. At which point will it be the greater? Does the specific gravity of the gas have any influence upon the amount of this difference between the pressures at the two points? Give the reasons for your answers.

7. What are the chief commercial products obtained by the gas manufacturer from the distillation, in retorts, of a ton (2,240 lbs.) of average Pittsburg or Youghioghenny coal; what amount of each is produced and what effect has the temperature of the retorts upon these amounts?

8. What substances are employed to free gas from ammonia (NH_3) and sulphuretted hydrogen (H_2S) respectively, and from carbonic acid (CO_2) and bisulphide of carbon (CS_2), in case it is desired to remove the last two impurities?

9. What kinds of joints are commonly employed for connecting together the separate lengths of cast-iron gas pipes? What are the respective advantages?

10. When globes are used in connection with flat flame gas burners, what effect does the size of the bottom opening of the globe have upon the light given out by the burner? How do the various materials of which such globes are usually made act in absorbing the light produced by the burner?

11. What are the different forms of atmospheric burners usually employed for the top burners of gas cooking stoves,

and which form do you consider the best for this purpose? Give the reasons for your choice.

12. What are the characteristics of a good building sand?

(Answers to these questions are due September 1st.)

Answers to Third Series of Questions—Section of 1906—Practical Class—American Gas Light Association.

Answers to all of these questions have been published in previous volumes of the Proceedings, and can be found there as follows:

No. 1, Vol. XVII, page 121.
No. 2, Vol. XVII, page 122.
No. 3, Vol. XVII, page 127.
No. 4, Vol. XVII, page 129.
No. 5, Vol. XVII, page 132.
No. 6, Vol. XVII, page 133.
No. 7, Vol. XVII, page 135.
No. 8, Vol. XVII, page 136.
No. 9, Vol. XVII, page 137.
No. 10, Vol. XVII, page 138.
No. 11, Vol. XVII, page 140.
No. 12, Vol. XV, page 39.

The President:—Gentlemen, you have heard the report. What is your pleasure?

Mr. C. H. Graf (Detroit, Mich.):—I move that the report be accepted and inserted in the Proceedings, including the questions and answers sent out to the class last year. (Carried.)

The President:—The report of the other Special Committees will be postponed for the present, and we will now hear from the Committee on Nominations.

Mr. Edward G. Pratt (Milwaukee, Wis.):—The Committee on Nominations beg leave to report as follows:

REPORT OF NOMINATING COMMITTEE.

DETROIT, Mich., October 22, 1903.

American Gas Light Association:

GENTLEMEN:—We present the following nominations for officers and members of the Council for the ensuing year:

PRESIDENT—Rollin Norris, Philadelphia, Pa.

FIRST VICE-PRESIDENT—Edward G. Cowdery, St. Louis, Mo.

SECOND VICE-PRESIDENT—Chas. F. Prichard, Lynn, Mass.

THIRD VICE-PRESIDENT—Charles R. Faben, Jr., Toledo, Ohio.

SECRETARY AND TREASURER—Alfred E. Forstall, New York City.

MEMBERS OF COUNCIL WHOSE TERMS EXPIRE IN 1905.

Arthur G. Glasgow, New York City.
John Williamson, Chicago, Ill.
Wm. A. Wood, Boston, Mass.
Walton Clark, Philadelphia, Pa.

Respectfully submitted,

EDWARD G. PRATT,
HENRY L. DOHERTY,
W. C. MORRIS,
WM. E. MCKAY,
JOHN GRIBBEL,
Committee.

THE PRESIDENT:—Gentlemen, you have heard the report. What action will you take upon it?

MR. JANSEN HAINES (Des Moines, Ia.):—I move that the report be accepted and that Mr. Pratt be directed to cast the ballot of the Association for the election of the officers as read. (Carried.)

THE PRESIDENT:—I will appoint as tellers Mr. T. D. Miller and Mr. A. H. Barret.

(Mr. Pratt deposited the ballot with the tellers.)

Mr. T. D. Miller (New Orleans, La.) :—Mr. President, the tellers have to report that by the ballot just cast the gentlemen whose names were read have received the unanimous vote of the meeting as the officers of the Association for the ensuing year.

The President :—Gentlemen, you have heard the report of the tellers. The gentlemen named are hereby declared elected. We would like to hear from Mr. Norris.

Mr. Rollin Norris (Philadelphia, Pa.) :—I thought I was going to get out of making a speech. I wish to thank the Association most heartily for this election and to express my high appreciation of what it means. I want the hearty co-operation of all the members of the Association in the ensuing year, as I am ambitious to make the meeting of 1904 a thoroughly successful one. The President individually can do very little, really, to this end, as it is entirely a matter for the Association, but what I can do I will do. Again I thank the Association for the honor of my election.

The President :—Mr. Cowdery, we would be pleased to hear from you.

Mr. Edward G. Cowdery (St. Louis, Mo.) :—Mr. President and Gentlemen : I do not think that the First Vice-President should be called upon for a speech. I think the President should have made a better one, which should have answered for both. However, I return my thanks to the gentlemen for having pushed me along in the procession towards the Presidency, and when my turn comes to serve as President, if I ever do, I shall certainly try to do all I can in that office, as I will in the present office of Vice-President.

The President :—We have Mr. Prichard with us.

Mr. Charles F. Prichard (Lynn, Mass.) :—Mr. President : It seems to me proper that the Second Vice-President should remain in obscurity — he is between the advance guard of the First Vice-President and the rear guard of the Third Vice-President ; and later, perhaps, he may be heard from.

THE PRESIDENT:—Mr. Charles R. Faben, Jr., of Toledo, who has been elected Third Vice-President, is not present just now, although in attendance at the Convention. I hope we will hear from him. The next in order will be the address of the President. Will Mr. Norris take the chair?

The President then read the following:

PRESIDENT'S ADDRESS.

GENTLEMEN:

Since our last meeting there have been no startling developments in our business, though there are several matters of interest that might be touched upon.

During that meeting there was in progress one of the most expensive and serious strikes known to this country. Directly or indirectly it affected every person east of the Mississippi from the Lakes to the Gulf of Mexico. The gas industry was especially influenced. On the one hand, it was almost impossible to get fuel that would make gas, and on the other, the demand for our product was unprecedented, taxing the works and mains beyond all expectation. While the coal strike of 1902 was officially at an end before the first of November of last year, the scarcity of fuel was felt until June last, and the high prices growing out of the strike are still with us. While anthracite coal was selling at fancy prices, some as high as $26.00 a ton within two hundred miles of the mines, a large amount of the Welsh anthracite was imported for making water gas. It was hoped that this coal would prove a satisfactory substitute for the American anthracite, but it fell far short. It would make gas, and was better than nothing, but it is not only unsatisfactory in the generators, but does not even make a good fuel for boilers. It is hard to kindle, and is difficult to keep alight. The great demand made coke almost as scarce as anthracite, and it was not always possible to substitute the former, so it is a lasting record of the energy and expedients of the gas industry that the supply of gas was maintained.

The coal gas manufacturer fared better than those equipped only to make water gas, but he was not free from trouble. The great demand for all fuel and the action of the railroads

in saving themselves at the expense of the shippers made it very difficult to keep supplied.

The first thing that gas companies should do is to increase their capacity for storage and put in sufficient coal to last at least five or six months, or probably for a year. The old practice of carrying six or eight weeks' supply is no longer a safe one to follow, and for the safety of the business the coal stores should be enlarged and kept full.

The second step for the companies to take is to ally themselves with the reputable builders and manufacturers in each city for the purpose of preventing lawlessness, the restriction of output, and interference with non-union labor. The laborers and mechanics are, as a rule, good, law-abiding citizens, but are too ready to listen to the voice of the demagogue. The latter is always with us, and it is not unreasonable to expect him to use the powerful weapons which have been put into his hands by the many shameless combinations of capital which have put the cost to the consumer of so many articles of every-day use so high as to almost prohibit consumption. In this case the innocent suffer usually more than the guilty, and they must take means to protect themselves.

That some concerted action is necessary, is shown by other events than the coal strike. You are all familiar with the blackmail exacted by the leaders of the trades unions in New York. In another city the militia which had been called out by the Governor was sent home at the request of the company because it was aiding the strikers in the destruction of property. These and hundreds of other cases show the drift towards lawlessness, and the aid and comfort that the unions get from those whose duty it is to preserve the peace. A careful study of recent strikes shows further that many are aimed against individuals or single corporations, with the idea of reducing them one at a time until all are in a state of subjection. It is not only good policy, therefore, but necessary, that those responsible for invested capital should work together. As a force is most potent and awe inspiring when least understood, it is a great advantage to work quietly and as far as possible without the general public having knowledge even of the existence of the association.

Returning to the coal strike, we find it was not entirely without its advantages to the gas interests. Thousands of people discovered for the first time that gas is an ever ready, cheap and convenient fuel, and this will not be readily forgotten. The increased price of coal, which still maintains, also encourages the use of a substitute, which the gas companies of this country have not been slow in offering. The silver lining, in this case at least, is very evident and is a source of great comfort.

Since our last meeting two installations of inclined retorts have been put into operation in this country. The make per foot of retort, on which so much depends, seems to be sufficiently high to prove this method the cheapest for carbonizing coal, interest and depreciation included. There are in use in France and Germany, machines for propelling coal at a velocity claimed to be sufficient to easily and satisfactorily charge a twenty-foot retort. If this claim is made good, this will be a powerful ally for the horizontals, and may bring the latter to the front as the most economical system.

Some progress is being made in coke ovens, and a contract was recently made by a company to buy four millions daily from this source. The company furnishing this gas has an installation that contains many improvements in design, which go to cheapen the operation and reduce wear and tear, and further, has facilities for storing a month's supply of coal. The damages arising from a failure to supply the gas as agreed, will be a large inducement to keep the stores well filled.

There is a continual evolution in design. The cheapening of cement has largely increased the use of concrete for foundations, retaining walls, engine settings, floors, etc. The use of conveyors and labor-saving machinery is increasing. More attention is being given to economy in boilers, engines and pumps. Purifying boxes are being deepened and enlarged, and, as a whole, the gas business is easily keeping abreast of other manufacturing concerns.

There seems to be more room for progress in the efficiency of lighting burners than elsewhere. The high pressure incandescent gas burner has an illuminating power of forty candles for each foot of gas burned. This seems high, but

with an average gas having 700 British thermal units per foot, the efficiency is only 5.3 per cent. Compared with the electric arc, which has an efficiency of 27.1%, this looks small. The following is a table of the efficiencies of the sources of light in common use :

Series arc, 1 watt per candle	27.01%
Enclosed arc, 1.4 watt per candle	19.03%
Nernst lamp, 1.6 " "	17.00%
Incandescent electric lamp, 3.5 watts per candle	7.75%
Incandescent gas lamp, 40 candles per ft.	5.03%
" " 20 " "	2.65%
Open flame " 5 " "	.66%
Oil lamp	.59%

This table shows the great opportunity for improvement in the efficiency of gas burners, and, taken with the great strides that have been made in the past few years, should be full of encouragement to those interested in our business. The nearer one approaches perfection the less incentive there is to further effort, so on the above showing, the gas people should work much harder than the electricians.

There is an unfortunate and growing tendency among those responsible for the commercial end of the gas business to push the sale of lamps containing clusters of incandescent mantles in close proximity to each other. This practice is bad from almost every point of view. The fundamental principle of good lighting is violated in that the sources of light are concentrated instead of being scattered. Economy and efficiency in operation are sacrificed, as the effective light produced from a foot of gas is less than is the case when single burners are used. As usually constructed, one mantle of the group may be used or all may be used together, but no intermediate number may be kept lighted at one time ; therefore, they are not convenient. The best friend of this lamp does not claim it to be beautiful, so what remains? The only argument that I have ever heard in its favor is that a certain class whose taste has been vitiated by the use of electric arc lamps will buy the "Gas Arcs" when they will not buy anything else, especially as the latter can be sold slightly cheaper than a

chandelier with burners and shades. As we refuse to sell or encourage the sale of cooking or heating appliances which we do not believe to be satisfactory and economical, are we not making a mistake in pursuing the opposite course in lighting appliances? It is better to lose a customer than to encourage the use of a lamp that in the long run cannot fail to hurt the gas business.

In this connection it would be proper to refer to the movement in England in the direction of reducing the illuminating power of gas. The quality of coal used and other local conditions may render such action eminently proper there, but conditions do not justify it in this country. A number of experiments indicate that a reduction of one candle in the illuminating power of the average commercial gas will reduce the heating power three per cent. Starting with twenty candle gas the reduction of a candle means five per cent. in light and three per cent. in heat. Assuming that the reduction does not decrease the duty of the incandescent gas burner, the advantage thus gained is more than off-set by the loss in the open flame burners. If, therefore, we assume that we are selling heat alone and not light, how many companies can afford to reduce the selling price three per cent. in order to compensate for the reduction of one candle in the illuminating power? The investment will increase as the heating power decreases, so there is a double reason to keep the calorific value of the gas as high as possible.

I must again call your attention to the work of the Association itself. This has been referred to by many of my predecessors, but conditions do not seem to improve. I refer particularly to the writing and discussion of papers. Papers can seldom be secured from a member except through the intercession of personal friends, and at the meetings too few join in the discussions. During the past four years the average attendance has been 188 and the average number of speakers 44, or 23 per cent. The number of individuals attending during the four years was 393, and the number of individual speakers was 109, or 27.7 per cent. A number of those speaking were heard only once or twice during the four years, so the number taking an active part in the proceedings

narrows down until it is very small. This is not as it should be, and I believe that the members are prepared to do better if the subject is properly presented. Membership in our Association is valuable and should be appreciated, but the members should recognize that it carries certain obligations. A member's duties are by no means discharged when he pays his dues, and, unless he does much more than this, he is not carrying his end of the burden.

I would respectfully suggest that the duty of obtaining papers be delegated to the Council of the Association, or to a committee appointed by the Council. Having decided in advance upon two or three subjects for discussion, each subject should be allotted to three or four members of the Association, and each member receiving such an allotment should prepare a paper on the subject. In addition, half a dozen members should be asked to come prepared to discuss each subject. By carefully selecting the members from those favoring and those opposed to a method or system, the evidence would be more conclusive than it is at present.

I regret that more progress in the adoption and use of the street main standards cannot be reported. As no objections have been urged to the standards proposed, it is to be assumed that the members not using them are not willing to assume the small trouble and expense necessary to make the change. The members should realize that the general adoption will cheapen the cost of specials in the long run, and, on that account, if on no other, they should put the standards in use with the least possible delay.

I respectfully recommend to your consideration the Report of the Trustees of the Gas Educational Fund and the paper prepared by Mr. A. C. Humphreys on the work that has been done. Each member should listen carefully to the paper and report and should then do everything possible to help along this great, good work. Much has been already accomplished and much more will be accomplished in the future. The questions and answers, which may be found in the Proceedings of the Association, will prove good reading for anyone interested in the gas business, and there are few who cannot gain something by their perusal. If those connected with our

business, and who are not qualified or eligible to take up the class work, will obtain the bound copies of the Proceedings and study the questions and answers, they will be many times repaid for their trouble. The work done by the Trustees is directly in furtherance of the object for which our Association was formed as declared in the Constitution, "The promotion and advancement of knowledge, scientific and practical, in all matters relating to the construction and management of gas works, and the manufacture, distribution and consumption of gas." This increase of knowledge in the end benefits every gas undertaking in the country, and, in assisting in the work, each company is advancing its own interests.

You have all received a copy of the Report of the Committee on Uniform Accounts. This is a splendid work, and, if the system suggested is generally adopted, our industry will be greatly benefited. The Association was fortunate in being able to secure the services of three men of such unusual experience and ability. Such men are rare and their time is valuable, so we are peculiarly fortunate that they were willing to devote so much of their time to our work. Every detail of the Report shows the study and care devoted to it, and it should be a lasting inspiration to every member. The members of our Association, individually and collectively, are under obligations to the members of this committee which can never be repaid. I recommend its careful study by every member of the Association, and hope that all will use their influence to secure its adoption by the companies in which they are interested.

We lost through death last year five of our members. A sixth, Mr. E. B. Knight, of Far Rockaway, N. Y., died June 17, 1902, but his death was not reported to our secretary until recently.

The gas industry and our Association have sustained a severe loss in the death of Mr. Eugene Vanderpool. A member of the American Gas Light Association since the year of its organization, he had always worked to increase the efficiency and usefulness of the Association and to advance the interests of the gas industry. He was an enthusiastic supporter of our Correspondence Class, and was a Trustee of

the Gas Educational Fund. His influence reached far beyond the gas industry and everything with which he came in contact was thereby dignified and uplifted. It is not necessary to remind those who knew him that his loss is a personal bereavement, but for the benefit of those who were not so fortunate I wish to say that our Association has lost one of its best friends.

We miss to-day the genial face of our old friend, H. B. Leach. He joined our Association in 1882, and from that time until now he has missed but one meeting. On July 25th last death claimed him almost without previous warning. He leaves a host of friends among whom his place can never be filled.

Mr. Wm. K. Park, who joined the Association in 1885, died during the past year.

Mr. Julius Buss died on November 23d last. He had been a member of our Association since October, 1892.

Mr. Frederick A. Welles, who joined the Association at our last meeting, died on December 16th.

VICE-PRESIDENT NORRIS :—Gentlemen, we have heard a very interesting address. It is usually customary to refer the President's address to a committee. If there is no objection, therefore, I will appoint as such a committee Mr. Walton Clark, Mr. Irvin Butterworth and Mr. W. C. Morris.

The President resumed the chair.

THE PRESIDENT :—Gentlemen, the next order of business is the continuation of the reports of special committees. The first will be that on Electrolysis. Is Mr. Hall or Mr. Curtis here ? If neither of those gentlemen is in the room we will hear from the Committee on Municipalization, Mr. Rollin Norris, Chairman.

Mr. Norris then read the report of the Committee.

REPORT OF COMMITTEE ON MUNICIPALIZATION.

PHILADELPHIA, Pa., Oct. 20, 1903.

MR. PRESIDENT :—This Committee was appointed to keep track of the development of the municipal ownership idea, in reference particularly to gas and electric light companies.

In considering how best to show the drift of sentiment and action in this line, it seems well to start with a list of the gas works and electric light works owned or operated by municipalities, and from year to year show the changes in this list.

With this in view, we submit the following list of cities which operate gas works in the United States :

Place.	Population, 1900.	Remarks.
Richmond, Va.	85,050	Operated by city.
Duluth, Minn.	52,969	"
Holyoke, Mass.	45,712	"
Wheeling, West Va.	38,878	"
Hamilton, Ohio	23,914	"
Anderson, Ind.	20,178	No facts.
Danville, Va.	16,520	Operated by city.
Alexandria, Va.	14,528	"
Westfield, Mass.	12,310	"
Henderson, Ky.	10,272	"
Wakefield, Mass.	9,290	"
Middleboro, Mass.	6,885	"
Bellefontaine, Ohio	6,649	"
Charlottesville, Va.	6,449	"
Fredericksburg, Va.	5,068	"
Dalton, Ga.	4,315	"
Santa Clara, Cal.	3,650	"
Dunkirk, Ind.	3,187	"

Total, 18.

To this list of 18 places may be added,

Philadelphia—Population, 1,293,697, which owns its Gas Works, but leases them to an operating company under a long term contract.

Louisville, Ky.—Population, 204,731, which owns about 25 per cent. interest in the local company.

Reading, Mass.—Population, 4,969, which has no gas plant, but buys its gas from the municipal plant at Wakefield.

Danville, Ky.—Population, 4,285, which owns about 20 per cent. interest in the Gas Company.

CHANUTE, KAN.—Population, 4,208, supplies natural gas under municipal operation.

It is rather noteworthy that of the eighteen cities operating municipal gas works, eight are located in the South, and only four have over 25,000 population.

The above facts are derived largely from the "Municipal Year Book of 1902," corrected to date as far as possible, and include only places having a population of 3,000 or over.

Next year, if the Committee be continued, it proposes revising the list, and noting the changes, if any.

In regard to laws passed on this subject, and places where municipalization has been actively discussed, our information is not as complete as the Committee hopes to have it another year, if continued.

In Burlington, Vt., an attempt to start a municipal electric plant was defeated early in September.

In Massachusetts the Holyoke case is too familiar to call for detailed discussion.

In Connecticut the Norwich matter is still pending, the city not having paid the company the purchase price fixed by the Committee.

In New York State, at North Tarrytown, a movement toward a municipal electric plant was defeated at the polls by a vote of the taxpayers of the town.

In California there is no constitutional provision granting the cities or towns the right to supply their inhabitants with artificial light or power. The last Legislature passed certain enabling acts, granting new charters to some cities, giving them the right to supply the inhabitants with artificial light and power. None of these cities have as yet availed themselves of the privileges granted.

In San Francisco, at a special election on Oct. 8, 1903, held for the purpose of voting on the acquirement of one of the Street Railway Companies, the people voted, by a large majority, not to municipalize the railway.

On Sept. 28, 1903, the town of Santa Ana, Cal., voted in favor of a municipal electric plant.

The last California Legislature took action which is regarded as favorable to private ownership of lighting plants, by repealing

an old law which limited the term of public contracts for lighting streets and public buildings to one year, and in its stead passed a law permitting cities and towns of less than 10,000 population to make contracts for any reasonable time, while all cities may in their charters provide a length of term of such contracts, and in the absence of any such provision there is no limitation. The old one-year contract for lighting streets and public buildings was considered a hardship on the gas companies.

The *Electrical World and Engineer*, issue of Sept. 26, 1903, page 527, says: "A special telegram from Valley City, N. D., says: 'The City Council has decided to offer the electric light plant for sale. A twenty-year franchise will be given the purchaser. There are about 3,000 commercial lights on the system, and it is said to be the largest plant, outside of Fargo and Grand Forks, in the State. It has not been a paying investment for the city, and the expenses of the past year were about $7,000 more than the receipts.'"

The "Municipal Year Book of 1902," mentioned before, gives a list of 1,418 places of 3,000 population or over, operating electric light plants. Of these, 195 are municipally operated, 84 more have both private and municipal plants, and four have some form of joint operation.

A list of these 283 places is appended, and an endeavor will be made to bring this list up to date each year, showing the changes which may occur.

Probably the majority of these cities operating municipal electric light plants supply current only for public lighting, and we will endeavor next year to show what proportion of these municipally operated electric plants go into the commercial lighting.

(Signed)

ROLLIN NORRIS, *Chairman.*
E. C. JONES,
GEORGE MCLEAN,
CHARLES H. NETTLETON,
Committee.

MUNICIPAL ELECTRIC PLANTS.

IN CITIES AND TOWNS OF 3,000 POPULATION AND OVER—CENSUS 1900.

PLACE.	POPULATION.	
Chicago, Ill.	1,698,575	Municipal and private.
Detroit, Mich.	285,704	" "
Allegheny, Pa.	129,896	Municipal.
Columbus, Ohio	125,560	Municipal and private.
St. Joseph, Mo.	102,979	Municipal.
Grand Rapids, Mich.	87,565	Municipal and private.
Nashville, Tenn.	80,065	" "
Holyoke, Mass.	45,712	Joint.
Wheeling, West Va.	38,878	Municipal and private.
Little Rock, Ark.	38,307	" "
Galveston, Tex.	37,789	" "
Tacoma, Wash.	37,714	" "
Springfield, Ill.	34,159	Municipal.
Topeka, Kan.	33,608	Municipal and private.
Taunton, Mass.	31,036	Municipal.
Jacksonville, Fla.	28,429	Municipal and private.
Bay City, Mich.	27,628	" "
Fort Worth, Tex.	26,688	" "
Easton, Pa.	25,238	Municipal.
Kalamazoo, Mich.	24,404	Municipal and private.
Aurora, Ill.	24,147	" "
Hamilton, Ohio	23,914	" "
Lewiston, Me.	23,761	" "
Bloomington, Ill.	23,286	" "
Jamestown, N. Y.	22,892	" "
Elgin, Ill.	22,433	" "
Morristown, Pa.	22,265	Municipal.
Austin, Texas	22,258	Municipal and private.
Bangor, Me.	21,850	Municipal.
Muncie, Ind.	20,942	Municipal and private.
Decatur, Ill.	20,754	" "
Anderson, Ind.	20,178	Municipal.
Paducah, Ky.	19,446	Municipal and private.
Chicopee, Mass.	19,167	" "

Galesburg, Ill.	18,607	Municipal and private.
Richmond, Ind.	18,226	" "
Newark, Ohio	18,157	" "
Marion, Ind.	17,337	" "
Cumberland, Md.	17,128	" "
Danville, Va.	16,520	Municipal.
Lansing, Mich.	16,485	"
Alameda, Cal.	16,464	"
Logansport, Ind.	16,204	"
Jacksonville, Ill.	15,078	Municipal and private.
Alexandria, Va.	14,528	Municipal.
Jackson, Tenn.	14,511	Municipal and private.
Watervliet, N. Y.	14,321	Municipal.
Hagerstown, Md.	13,591	Municipal and private.
Marietta, Ohio	13,348	Municipal.
Owensboro, Ky.	13,189	"
West Bay City, Mich.	13,119	"
Ashtabula, Ohio	12,949	"
Hannibal, Mo.	12,780	"
Nome, Alaska	12,486	Municipal and private.
Westfield, Mass.	12,310	Municipal.
Dunkirk, N. Y.	11,616	"
Marshalltown, Iowa	11,544	Municipal and private.
Peabody, Mass.	11,523	Municipal.
Ottawa, Ill.	10,588	Municipal and private.
Lasalle, Ill.	10,446	" "
Meadville, Pa.	10,291	Municipal.
Henderson, Ky.	10,272	"
Sioux Falls, S. D.	10,266	Municipal and private.
Vincennes, Ind.	10,249	Municipal.
Athens, Ga.	10,245	Municipal and private.
Sherman, Texas	10,243	" "
Marquette, Mich.	10,058	Municipal.
Carlisle, Pa.	9,626	Municipal and private.
Mattoon, Ill.	9,622	" "
Escanaba, Mich.	9,549	Municipal.
Huntington, Ind.	9,491	Municipal and private.
Waterville, Me.	9,447	Joint.
Carthage, Mo.	9,416	Municipal and private.

Frederick, Md.	9,296	Municipal and private.
Wakefield, Mass.	9,290	Municipal.
Batavia, N. Y.	9,180	Municipal and private.
Chambersburg, Pa.	8,864	Municipal.
Washington, Ind.	8,851	"
Danvers, Mass.	8,542	"
Peru, Ind.	8,463	"
Titusville, Pa.	8,244	Municipal and private.
Bowling Green, Ky.	8,226	" "
Emporia, Kan.	8,223	Municipal.
Columbus, Ind.	8,130	Municipal and private.
Tyler, Texas	8,069	" "
Wellston, Ohio	8,045	Municipal.
St. Charles, Mo.	7,982	Municipal and private.
Riverside, Cal.	7,973	" "
Goshen, Ind.	7,810	" "
Holland, Mich.	7,790	Municipal.
Martin's Ferry, Ohio	7,760	"
Grand Forks, N. D.	7,652	Municipal and private.
Marblehead, Mass.	7,582	Municipal.
Brainerd, Minn.	7,524	"
Niles, Ohio	7,468	"
Ypsilanti, Mich.	7,378	Municipal and private.
Staunton, Va.	7,289	" "
Galion, Ohio	7,282	Municipal.
North Attleboro, Mass.	7,253	"
Fremont, Neb.	7,241	Municipal and private.
Hastings, Neb.	7,188	Municipal.
Conneaut, Ohio	7,133	"
West Springfield, Mass.	7,105	Municipal and private.
Frankfort, Ind.	7,100	Municipal.
Negaunee, Mich.	6,935	Municipal and private.
Middleboro, Mass.	6,885	Municipal.
Peru, Ill.	6,863	"
Greenville, Texas	6,860	"
Griffin, Ga.	6,857	"
Rochester, Minn.	6,843	"
Sharpsburg, Pa.	6,842	"
New Iberia, La.	6,815	"

Wallingford, Conn.	6,737	Municipal.
Millvale, Pa.	6,736	"
Crawfordsville, Ind.	6,649	"
Bellefontaine, Ohio	6,649	"
South Norwalk, Conn.	6,591	Municipal and private.
Norwood, Ohio	6,480	Municipal.
Charlottesville, Va.	6,449	"
Coldwater, Mich.	6,216	"
Olyphant, Pa.	6,180	"
Blue Island, Ill.	6,114	"
Paris, Ill.	6,105	Municipal and private.
Braintree, Mass.	5,981	Municipal.
Troy, Ohio	5,881	"
Goldsboro, N. C.	5,877	"
Iola, Kan.	5,791	"
Santa Cruz, Cal.	5,659	Municipal and private.
Concord, Mass.	5,652	Municipal.
Grafton, West Va.	5,650	Municipal and private.
Alexandria, La.	5,648	Municipal.
Middletown, Pa.	5,608	"
Mishawaka, Ind.	5,560	"
Herkimer, N. Y.	5,555	"
Austin, Minn.	5,474	"
Hudson, Mass.	5,454	"
Monroe, La.	5,428	"
Etna, Pa.	5,384	"
St. Mary, Ohio	5,359	"
Petoskey, Mich.	5,285	"
Mount Vernon, Ill.	5,216	"
Wyandotte, Mich.	5,183	"
St. Joseph, Mich.	5,155	Municipal and private.
Ilion, N. Y.	5,138	Municipal.
Wellesley, Mass.	5,072	Municipal and private.
Fredericksburg, Va.	5,068	Municipal.
Hingham, Mass.	5,059	Joint.
Atlantic, Iowa	5,046	Municipal.
Monroe, Mich.	5,043	"
Painesville, Ohio	5,024	Municipal and private.
Galena, Ill.	5,005	Municipal.

Winchendon, Mass.	5,001	Municipal.
Reading, Mass.	4,969	"
Coffeyville, Kan.	4,953	"
Fulton, Mo.	4,883	"
Greenwood, S. C.	4,824	"
Portland, Ind.	4,798	"
Green Island, N. Y.	4,770	"
Grand Haven, Mich.	4,743	"
Fairfield, Iowa	4,689	"
Shelby, Ohio	4,685	"
Jackson, Ohio	4,672	"
St. Clair, Pa.	4,638	"
Lehighton, Pa.	4,629	"
Webster City, Iowa	4,613	"
Gastonia, N. C.	4,610	"
Newberry, S. C.	4,607	"
Albany, Ga.	4,606	"
Delray, Mich.	4,573	Municipal and private.
Ballard, Wash.	4,568	Municipal.
Rushville, Ind.	4,541	"
Greenfield, Ind.	4,489	"
Bluffton, Ind.	4,479	"
Orangeburg, S. C.	4,455	"
Gainesville, Ga.	4,382	"
Vineland, N. J.	4,370	"
Marshall, Mich.	4,370	"
Lawrenceburg, Ind.	4,326	"
St. Peter, Minn.	4,302	"
Niles, Mich.	4,287	"
Crowley, La.	4,214	"
High Point, N. C.	4,163	"
Dowagiac, Mich.	4,151	Municipal and private.
Hillsdale, Mich.	4,151	Municipal.
Decatur, Ind.	4,142	Municipal and private.
Fredonia, N. Y.	4,127	" "
Mount Pleasant, Iowa	4,109	Municipal.
Kinston, N. C.	4,106	"
Donaldsville, La.	4,105	"
Troy, Ala.	4,097	"

Harlem, Ill.	4,085	Municipal and private.
Chester, S. C.	4,075	Municipal.
Metropolis, Ill.	4,069	"
Macon, Mo.	4,068	"
Martinsville, Ind.	4,038	Municipal and private.
Laurens, S. C.	4,029	Municipal.
Princeton, Ill.	4,023	"
Needham, Mass.	4,016	Municipal and private.
South Haven, Mich.	4,009	Municipal.
Ravenna, Ohio	4,003	"
Chariton, Iowa	3,989	"
Greenfield, Ohio	3,979	"
La Grange, Ill.	3,969	"
Brownwood, Texas	3,965	Municipal and private.
Miamisburg, Ohio	3,941	Municipal.
Gaffney, S. C.	3,937	"
Belmont, Mass.	3,929	Joint.
Blakeley, Pa.	3,915	Municipal.
Wapakoneta, Ohio	3,915	"
Garrett, Ind.	3,910	"
Batavia, Ill.	3,871	"
Elberton, Ga.	3,834	"
Water Valley, Miss.	3,813	"
Two Rivers, Wis.	3,784	"
Madison, N. J.	3,754	"
Moorhead, Minn.	3,730	"
Ely, Minn.	3,717	"
Newton, Iowa.	3,682	Municipal and private.
Independence, Iowa	3,656	Municipal.
Schuylkill Haven, Pa.	3,654	"
Sycamore, Ill.	3,653	Municipal and private.
Santa Clara, Cal.	3,650	Municipal.
Napoleon, Ohio	3,639	"
Collinwood, Ohio	3,639	"
Gainesville, Fla.	3,633	Municipal and private.
Gas City, Ind.	3,622	Municipal.
Wilmington, Ohio	3,613	"
Uxbridge, Mass.	3,599	Municipal and private.
Shelbyville, Ill.	3,546	Municipal.

Wilson, N. C.	3,525	Municipal.
London, Ohio	3,511	"
Wappinger's Falls, N. Y.	3,504	"
Vinton, Iowa	3,499	"
Solvay, N. Y.	3,493	"
Harriman, Tenn.	3,442	"
Salem, Va.	3,412	"
East Chicago, Ind.	3,411	"
Willmar, Minn.	3,409	"
Union City, Tenn.	3,407	"
New Castle, Ind.	3,406	Municipal and private.
Montpelier, Ind.	3,405	Municipal.
Canton, Miss.	3,404	"
Auburn, Ind.	3,396	"
St. Johns, Mich.	3,388	"
St. Bernard, Ohio	3,384	"
Ocala, Fla.	3,380	"
Gladstone, Mich.	3,380	"
Lakewood, Ohio	3,355	"
Kendallville, Ind.	3,354	"
Dover, Del.	3,329	"
Savanna, Ill.	3,325	Municipal and private.
Washington, Ga.	3,300	Municipal.
Braidwood, Ill.	3,279	"
Two Harbors, Minn.	3,278	"
Dothan, Ala.	3,275	"
Reidsville, N. C.	3,262	"
Indianola, Iowa	3,261	"
Hudson, Wis.	3,259	Municipal and private.
Thibodaux, La.	3,253	Municipal.
Fernandina, Fla.	3,245	"
Estherville, Iowa	3,237	"
Crystal Falls, Mich.	3,231	"
West Point, Miss.	3,193	Municipal and private.
Dunkirk, Ind.	3,187	Municipal.
Cuyahoga Falls, Ohio	3,186	"
Waupun, Wis.	3,185	"
Butler, Mo.	3,158	"
Madisonville, Ohio	3,140	"

Bryan, Ohio	3,131	Municipal.
Vancouver, Wash.	3,126	"
Waseca, Minn.	3,103	"
Bridgeport, Pa.	3,097	Municipal and private.
Spencer, Iowa	3,095	" " "
Reading, Ohio	3,076	Municipal.
Linton, Ind.	3,071	"
Fort Atkinson, Wis.	3,043	"
Fairmont, Minn.	3,040	"
Winterset, Iowa	3,039	"
Barnesville, Ga.	3,036	"
Falls City, Neb.	3,022	"
Quakertown, Pa.	3,014	"
Port Washington, Wis.	3,010	"
Chestertown, Md.	3,008	"
Nantucket, Mass.	3,006	"
Attica, Ind.	3,005	"

Mr. R. B. Brown (Milwaukee, Wis.) :—I move that the Report of the Committee be accepted and that the Committee be continued for another year, in order that the Association may have the benefit of any further investigations which they may be able to make, more especially of any changes in the conditions under which municipal plants are being operated. (Carried.)

The President :—The next report is that of the Research Committee, Mr. Norris, Chairman.

Mr. Rollin Norris (Philadelphia, Pa.) :—Mr. President and Gentlemen : The Research Committee believes its chief function to be to promote research work, and during the last year it has confined its efforts to encouraging research work and to endeavoring to get the result of such work before the Association. Arrangements have been made with one of the companies which at present is conducting a series of experiments on purification, to embody the result of this work in a paper to be read before the next meeting of the Association. This paper is intended to take up the question of the best kind of oxide, the effect of the depth of boxes on their capacity, the best number of boxes to have in series, etc.

Also the effect of varying proportions of oxygen on the capacity of the boxes, and on the work that each box does; that is to say, to show how the introduction of the oxygen shifts the work from the later boxes in the series toward the earlier ones.

In addition to this there are some experiments now making on consumers' meters, with reference more particularly to their capacity, and to improvements in design which will affect capacity. As we all know, there is a marked difference, especially in the larger meters, in the actual capacity of meters of different makes of the same rated sizes, and it was with the idea of running this down that these experiments were started. It is an interesting subject and, I think, promises to give interesting results. That is the sum total of the efforts of the Research Committee for the past year.

THE PRESIDENT:—Gentlemen, you have heard the Report of the Research Committee. What is your pleasure?

MR. C. J. R. HUMPHREYS (New York City):—I move that the Report be accepted and the Committee continued. (Carried.)

THE PRESIDENT:—I will appoint as a committee on the next place of meeting, Messrs. C. J. R. Humphreys, Edward G. Cowdery and Walton Clark.

The Committee on the Beal Medal will be Messrs. Wm. R. Beal, Geo. G. Ramsdell and Edward G. Pratt.

I note, Gentlemen, that there are representatives present from certain foreign gas associations, whom we are very greatly pleased to welcome. It is a great pleasure to have them with us, and we hope they will take full part in our proceedings and that they will feel as much at home as though they were at the meetings of their own associations.

We have letters from some of our members and others who have been unable to attend. The Secretary will now read them.

The Secretary read a telegram from Wm. A. Baehr, St. Louis, and letters from W. R. Addicks, New York City; W. P. Knowles, Richmond, Va., and Paul Doty, Denver, Col.

THE PRESIDENT :—Gentlemen, we hardly have time now to take up a regular paper, but there are several questions here. I think we may take up some of these questions to fill in the time before the hour of adjournment. The first question is :

"What is an effective and economical method of stopping the fluctuation of the gas in a system of piping to which a gas engine is connected?"

Does any gentleman wish to make suggestions on that question? Someone must have some ideas on it.

MR. CARL H. GRAF (Detroit, Mich.) :—I have found, where the load is fairly constant, a very effective means is to put a cock on the inlet side of the gas bag, and choke it down until the gas bag fills gradually instead of all at once. I reduced the fluctuation in that way from about 6/10″ to 2/10″. This variation does not show on an open flame or a Welsbach burner. I have also tried the scheme of putting in an old meter case and placing on the inlet side a perforated lead washer, to allow the gas to pass slowly instead of suddenly, which latter gives the bad effect. Let the gas pass through gradually; but you cannot choke it down in this way if the load varies to any great extent.

MR. ROBERT M. SEARLE (Mt. Vernon, N. Y.) :—We have put two bags in tandem with the controlling cock just before the first bag. We use two bags to compensate somewhat for the variation in the load where the load is intermittent.

MR. WILLIAM J. SERRILL (Philadelphia, Pa.) :—In Philadelphia we use a diaphragm governor attached on the inlet of the gas bag, with a fair degree of success.

MR. JAMES SOMERVILLE (Indianapolis, Ind.) :—I was troubled a good deal about the fluctuation of the gas in the pipes when I was putting up gas engines, and it occurred to me to take an old meter—a thirty-light meter—and take the index off and attach the meter to the inlet pipe, and it stopped the fluctuations. How it did so I do not know, but it cured the trouble. The gas went through the meter and it was a very simple means of overcoming the difficulty. It did not cost much and did the business.

Mr. J. B. Klumpp (Philadelphia, Pa.):—Mr. Graf's principle of throttling the gas before it is admitted to the bag seems to be the most practical way of overcoming the difficulty of vibration of gas in the main. What we are after is to get a fairly constant flow of gas through the meter and service. A number of fairly successful installations have been made by inserting an ordinary tank or boiler in the service or gas line in tandem with the gas bag, and throttling the cock on the inlet to the tank.

An anti-fluctuator in connection with this scheme is now being put on the market by a New York firm, and although they do not use a bag with the tank, they have met with perfect success, reducing the variation in pressure with a 40 horse-power three-cylinder engine to about one-tenth of an inch at the meter, and in single and large cylinder engines running at slower speeds where the pulsations are most pronounced, have substituted an oil or hydraulic seal whereby the liquid is quickly raised at each stroke of the engine or pulsation of the gas, assisting in the rapid expansion of the gas and acting on the same principle as the rubber bag, the gas being throttled on admission to the tank.

In all cases, reduced vibration in the mains is obtained by having a larger size pipe connecting the tank or bag with the engine, and throttling the gas at the inlet to the tank or bag.

Mr. R. L. Kenah, Jr. (New Brighton, Pa.):—We have been using a diaphragm regulator and in connection with it a tank or gas reservoir similar to the plan already suggested. We place the tank on the gas line back of the regulator. The supply of gas to the engine is pumped by the suction of the engine from the tank, and on account of the surplus volume of gas in the tank there is very little or no fluctuation of pressure at any opening back of it, the supply to the engine being taken from the tank rather than the gas line.

For a tank I would recommend an ordinary range boiler. As a substitute for a tank one length of larger pipe than the supply line inserted in it will answer. We have found this arrangement very satisfactory in most cases.

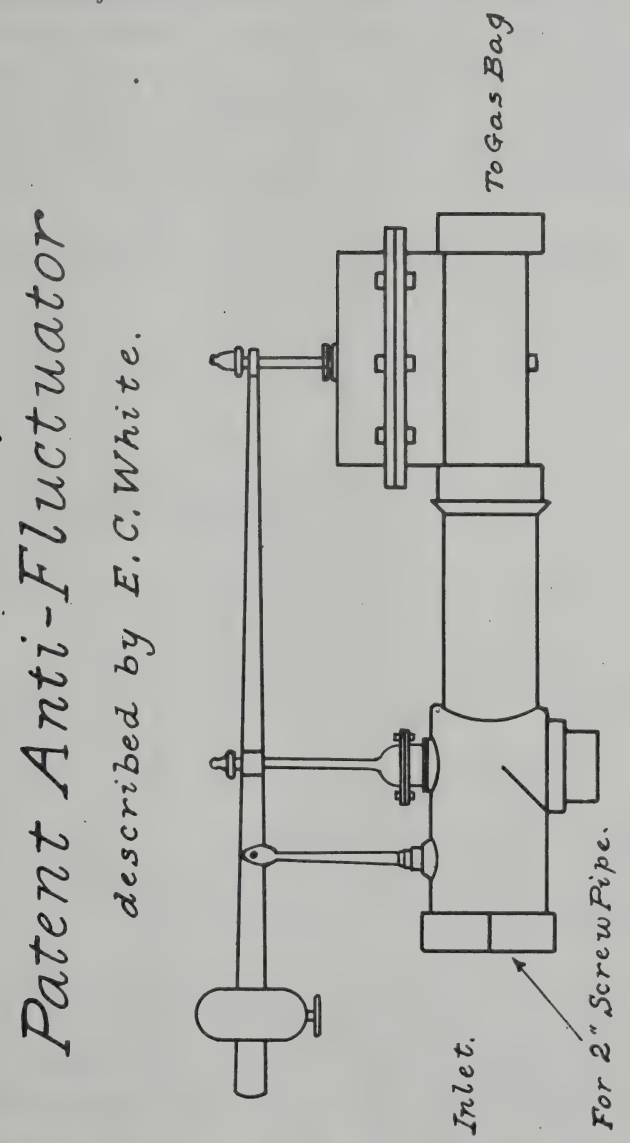
THE SECRETARY:—In connection with the matter of throttling, it occurs to me that it is necessary to be careful not to throttle down so much that the power of the engine is affected. It would be easy to overdo the throttling and keep the engine from developing its full power. I had a case in gas engine work in which the owners of the engine complained very bitterly that they could not develop the power the engine was supposed to develop—they said they did not get pressure enough. We ran the thing down and found there was a drop of only one-tenth in the pressure from the street main into the inlet of the gas bag, and we finally came to the conclusion that the gas bag was not large enough for the engine—as the engine drew in the gas on the stroke the gas bag collapsed, and the engine had to depend on the capacity of the pipe to finish out the stroke. That was cured by putting in a little floating governor, with sufficient capacity to supply the full amount of gas required for the stroke, acting as a small gas holder. That experience would make me careful as to the selection of the man who did the shutting down of the gas cock before the bag.

I have some answers from members not present.

MR. E. C. WHITE (Long Branch, N. J.):—Recently we introduced a 22 horse power gas engine at Sea Bright, and ran a three inch service in to supply it from a three inch main on a small side street about 300 feet from our six inch main on one of the main streets. There were only a few using gas on the side street. When the gas engine was running it affected the pressure on ranges for several blocks around. We cut in another three inch line from another alley, but got no better results.

We heard by chance of a patent anti-fluctuator, a foreign invention sold here by the American Meter Company for $12.00. After introducing it the trouble stopped. For the expense involved, I know of nothing better. This anti-fluctuator can be placed in any convenient space between the meter and the rubber bag which supplies the engine, in a horizontal position and as near the bag as convenient. The required pressure of gas is regulated by the adjustable weight,

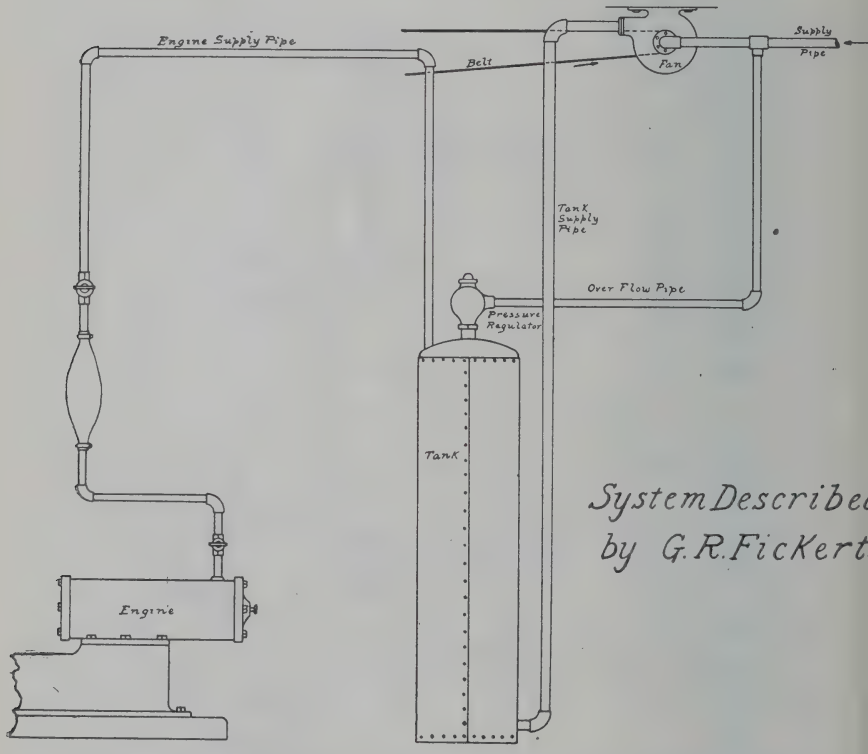
as shown on sketch. It requires no attention after being fixed and adjusted.



We have engines running here that have a small gas holder tank arrangement. This arrangement will prevent any fluc-

tuation of gas in the pipe system, where lights are used for ranges and lighting purposes, but for mine, the anti-fluctuator. It is easily introduced and gives no trouble. Suffice it to say it does the business.

Mr. Gustav Richard Fickert (New York City):—Communicated by S. Bernstein (New York City): — I beg leave to submit a sketch and explanation of an idea that appears to



me would be a practical means for overcoming the difficulty that suggests the question and which is as follows:

1st. By adding a system of piping and connections in which a higher pressure of gas is maintained than the natural pressure.

2d. The new system to consist of a pressure blower, gas tank or reservoir and a governor or pop valve.

3d. The inlet side of the blower to be connected anywhere on the old line of piping. The outlet side of the blower to the tank.

4th. The blower to run a given number of revolutions so as to maintain a pressure of 4″ of water between the tank and engine when engine is running under heaviest load.

5th. The pop valve, which is located on the top of the tank, has its outlet connected to the same pipe which leads to the blower a short distance away from same.

As will be seen, the tank being under higher pressure will take care of all fluctuations. The action of the blower, running under fairly high speed, will not be noticeable to the lights supplied from the regular piping, and any slight overflow from the tank back into the pipes will be taken in by the blower.

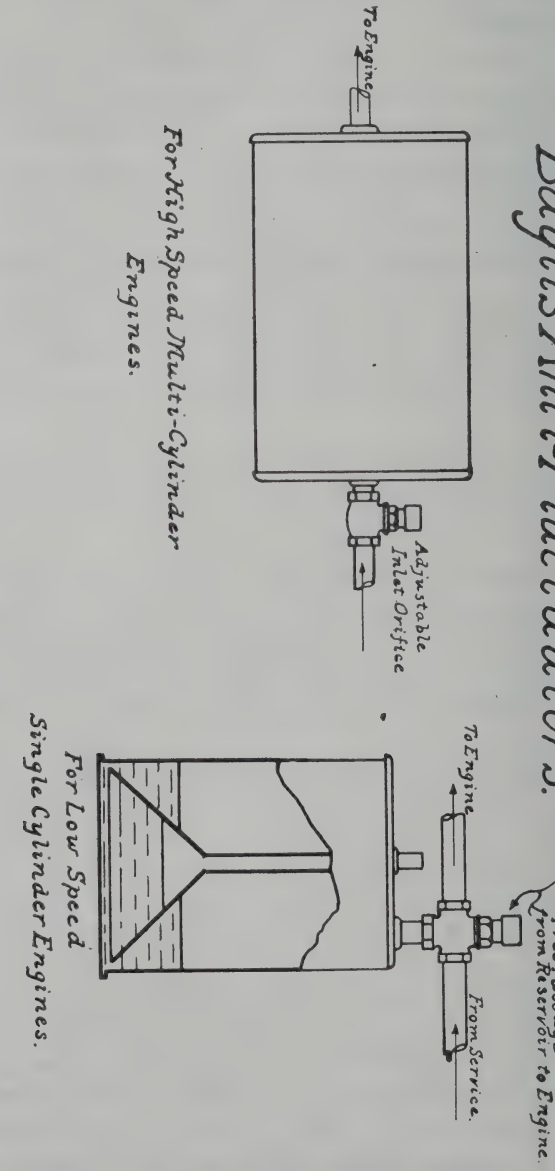
The cost of installation will not be very expensive, while the cost of running and maintaining would be about ten cents per day for 10 horse power.

Mr. R. R. Young (Passaic, N. J.):—I send a cut of the "Baylis Anti-fluctuator," which fills the bill entirely in stopping the fluctuations of the gas pressure on lines connected with the supply pipe of a gas engine. I also send a copy of a letter received from Mr. R. N, Baylis, giving a full explanation of cut:

"My candid opinion is that the most 'effective and economical method of stopping the fluctuation of the gas in a system of piping to which a gas engine is connected' is to use a Baylis Anti-fluctuator, which is the result of a very careful study I have made of the conditions under which gas engines operate. Its action is based upon the elastic property of the gas.

"In this device, instead of allowing the engine to pump its supply directly from the piping system, or through a rubber bag, a reservoir suited to the capacity of the engine is provided, and the inlet to this reservoir is restricted to a sufficient extent to equalize the flow in the system to a degree that will render the fluctuation in the supply pressure imperceptible. This reduces the apparatus to one of the very simplest con-

struction and of a permanent nature, being constructed entirely of metal with no moving parts to get out of order. When



once installed and adjusted it never requires any further attention.

"This anti-fluctuator may be used effectively on all types and sizes of gas engines. It is used in its simplest form above described, with eminently satisfactory results, on engines running at relatively high speeds and on multiple cylinder engines, and for low speed, single cylinder engines, including those in which the inlet valve is not mechanically operated, a modification of the above is employed in which the reservoir has an inner chamber in communication with the atmosphere and a non-volatile liquid seal is used. The arrangement of the device is such, however, that escape of gas due to any excess of pressure in the main is impossible. Moreover, the apparatus cannot be rendered inoperative or put out of order through shutting off the service before closing the engine valve, as frequently happens with so-called 'equalizers' having liquid seals.

"The reason for using the modified form just referred to is that the size of reservoir needed to produce effective results depends upon the cylinder capacity of the engine and the interval between successive charges, and in the case of low speed, single cylinder engines of considerable power the size of reservoir in the simpler form becomes objectionable. In the modified form the dimensions are kept well within practical limits."

Mr. Frederic Egner (Washington, D. C.) :—We had a gas engine driving the elevators (passenger and freight) in the office building of the Laclede Gas Light Company, then on Eleventh Street, near Washington Avenue, St. Louis, Mo.

It was connected to the house-piping from which the building was lighted, and when running the elevator, the lights fluttered considerably.

I had (though engineer of the said company) nothing to do with fixing up the offices. That job was left to one of my assistants, Mr. George T. Thompson (since deceased and lamented), by the president of the company.

Finding the lights fluctuating to a very annoying extent, I directed Mr. Thompson to put an old meter prover between the inlet pipe to the gas engine and the house pipe; and after that there was not the slightest fluctuation in the gas.

It was interesting to watch the holder of the meter prover though, when the elevator engine was running.

I believe the same object could be accomplished if one of the Pittsburg Machine Company's "Connelly Automatic Gas Regulators" were to be inserted between engine and house pipe. But having never tried *that*, I merely throw in the suggestion.

The meter prover or a cheaper arrangement on that order will certainly do the work though.

THE PRESIDENT:—Are there any further suggestions? If not, we will take up the next question—"Is it likely or possible that gas under high pressure will ignite on being suddenly released through a small opening, in the absence of flame or spark?" This question has just come in. Perhaps some of our members who are familiar with electrical matters may tell us something about that. Will someone give us a suggestion in that connection?

MR. J. D. SHATTUCK (Chester, Pa.):—We have a good many occasions to let gas out suddenly. The tendency of the gas is to cool on expansion, so that there would be no heat friction of the gas coming through the outlet sufficient to ignite it. There is more or less moisture accompanying the expansion, and there would not likely be any electric sparks on this account.

MR. ISAAC N. KNAPP (Ardmore, Pa.):—In the natural gas business gas is sometimes found under a rock pressure of 500 or 600 lbs. After a gas well is drilled in, it is commonly packed and tubed, the hole through the packer being for a 2″ or 3″ or 4″ tubing or pipe, according to the capacity and condition of the well, and the tubing is closed with a suitable valve. If the valve controlling such gas well is suddenly opened the gas commences to escape under the high rock-pressure, and this pressure runs down until a constant or open flow pressure is reached, this final pressure depending on the volume of the well and the size of the pipe and it may be 30 lbs. at the open end of the pipe.

I have witnessed the drilling in of a number of gas wells and am acquainted with the natural gas business, but have

never heard of the accidental ignition of gas being attributed to an electric spark generated by friction of escaping gas, either at the well or in blowing out a pipe line.

THE PRESIDENT:—Gentlemen, you all know that steam escaping from a nozzle will generate electricity, if the boiler is insulated. Perhaps the gentleman who asked this question had in mind a pipe insulated by rubber joints, or something of that kind. Have any of you had experience with gas escaping under pressure from a piece of pipe which was insulated?

MR. I. N. KNAPP (Ardmore, Pa.):—The packing material of a gas well packer is of rubber usually about 16″ long, and one inch or more thick, and its outside diameter about equal to the inside of the casing. When the packer is entered in the top of the casing, and until it is passed some little distance in the well, the conditions might readily be such that the tubing for a time would be practically insulated, and we would have the case of the flowing of gas under quite a pressure through an insulated pipe.

MR. THOS. D. MILLER (New Orleans, La.):—I asked that question because we had an inch opening occur the other day in a line with 40 lbs. pressure on it, and one of our men attempted to stop the flow with his hand, but he gave it up and finally let go, and as he did so the gas ignited. From the best evidence I can find there was no possibility of a light or spark being nearer than 60 or possibly 100 feet. There was no one on the street passing at the time, and the two men present emphatically stated there was no light in the house because they had guarded against that, and it is the feeling of these men that the gas ignited itself. I did not believe it. The first thought which suggested itself to me was that the sudden reduction in temperature would have a tendency to prevent ignition. The fact stands, however, that the gas ignited and no known cause of its ignition has been discovered. I thought possibly the experience of our members, such as Mr. Knapp has related, might develop something I have not known or heard of. I do not think there was any electric spark. The pipe went direct to the ground.

MR. J. C. SLOAN (Rome, N. Y.) :—Was that natural or illuminating gas?

MR. THOS. D. MILLER :—Illuminating gas.

MR. SLOAN :—I have known natural gas to ignite owing to the deposits of carbon, or whatever it is, in the pipes coming in contact with the atmosphere. It may be that such a condition existed in the case Mr. Miller refers to.

MR. ROBERT M. SEARLE (Mt. Vernon, N. Y.) :—Was the pipe tested for electricity to see if it was carrying any current? A man well grounded, withdrawing his hand suddenly from the gas pipe, might generate a spark between his fingers and the pipe—just as you sometimes can get a spark from your fingers by touching a gas fixture.

MR. THOS. D. MILLER :—It was a 4″ wrought iron pipe coming up from the ground. The man stood on the floor and had his hand over the opening for probably half a minute, when the pressure of the gas forced the blood through until it came out on the top of his hand. He took his hand off to insert his hat between his hand and the opening, when the gas ignited.

MR. W. C. MORRIS (Long Island City, N. Y.) :—It seems to me the cause of such an accident might be a foreign substance in the pipe. The pipe might be suddenly jarred and the substance carried through the opening, making a spark as it came in contact with the outer surface of the pipe. This comes to my mind as a possible explanation.

MR. D. R. WARMINGTON (Cleveland, Ohio) :—Carbon di-sulphide, under high pressure, admitted into the air will ignite spontaneously.

THE PRESIDENT :—Mr. Sloan, did the carbon you spoke of ignite after coming into contact with the atmosphere?

MR. J. C. SLOAN (Rome, N. Y.) :—After the gas had been in use in Detroit a number of years the supply suddenly failed and our pressure was reduced from 100 lbs. to 2 lbs. at Detroit. During the first week of this failure there were great quantities of carbon deposited in service pipes, meters

and house pipes, in many instances completely shutting off the supply of gas.

At first it was thought the black dirt, as we then designated it, came from the gas wells, but as it gradually ceased to deposit after the first few days and after one week ceased entirely, I am positive it was merely a deposit from the gas inside the pipes which was swept off when the pressure was reduced at Detroit, and the gas came through the pipes like a whirlwind instead of under heavy pressure and with little loss of pressure between the field and Detroit.

We found in removing this deposit we had to exercise care, as it would ignite when exposed to the atmosphere.

Mr. Alfred E. Forstall (Montclair, N. J.):—I would ask Mr. Miller if there were any signs of oil coming out of that pipe with the gas? If seems to me if there was any oil, that some of the lighter oil might ignite at a very low temperature comparatively.

Mr. Thos. D. Miller:—Really, I cannot say as to that. There was no evidence of any oil left when the fire was put out. Everything was pretty badly burned. The fire was put out promptly, but nothing of that kind was left to be seen.

The President:—Are there any further suggestions in answer to the question, gentlemen?

We have one more question—"What gas companies in the United States have tried profit-sharing plans or co-operative methods with their employees, and on what lines and with what success?"

Mr. Cowdery, can you give us any information on that subject?

Mr. Edward G. Cowdery (St. Louis, Mo.):—The Milwaukee Company some four or five years ago adopted the plan of paying the employees a bonus for continual and faithful service. Under this plan any employee, after he had worked for the company for one year, became a subject for the receipt of this bonus. The bonus was paid at the end of each six months to those employees who had been regularly employed during the six months. It was decided that a man must

work five full months out of the six months to be considered as a regular employee. That gave an opportunity for the man to be off by reason of sickness, or for a slight vacation, or anything of that sort. This rule was strictly adhered to, and those only who had fulfilled the conditions received the bonus at the end of the period. The bonus paid, to start with, was six per cent. of their wages. How well this was appreciated by the men, I do not think we have ever fully known; but we have known that it was very greatly appreciated by the wives of the men. Among this class of workmen they are very apt, as you know, to take their money and spend it almost immediately, either by paying their debts or spending a portion of it for themselves, or something of that sort, and their wives receive comparatively little of it. But it seems, in the face of the bonus, that their wives knew about the time when it was due and calculated upon it and looked out to get their hands upon it. We found that this was the case, from the fact that the wives took the company's checks to the bank and had them cashed, and they spoke very favorably of the plan. They were especially appreciative of the gas company's action in this respect.

This bonus was continued—as I say, it was started some four or five years ago—until about a year and a half ago, I think. As the times came along when wages were being increased throughout the country we felt that something of the same kind might be expected from us, and we increased the bonus to ten per cent. instead of increasing the wages generally. I have no doubt, in my mind, that it had the effect of at least postponing, for a considerable time, any demand for increased wages. I think that there has been no demand during this period, for a general increase of wages, although I think the company has probably anticipated that to a very great extent and increased wages, showing that they are endeavoring in their own way to give it where it will do the most good.

I do not think that I can say to you any real, actual good has been accomplished beyond that which I have stated, and which we surmise has possibly been accomplished through the adoption of this bonus scheme.

THE PRESIDENT:—We have with us Mr. John West, of Manchester, England, and we would like him to be kind enough to tell us something of the experiences on the other side of the water on this question.

MR. JOHN WEST (Manchester, England):—Mr. President and Gentlemen: I may say that Mr. Livesey, of the South Metropolitan Gas Company, was the prime mover in the profit-sharing scheme. This was brought about through the difficulties they had some years ago in connection with a strike in London, and they thought that some means must be taken so as to keep their men more in touch with the interests of the company, and they decided to offer some induce. ment to prompt the men to join in the company with them. I cannot perhaps give you in minute detail the whole of the arrangement, but after a man has been in the employ of the company for a certain length of time he can have a number of shares allotted to him and he becomes a shareholder in the company, according to the time he has served and according to his conduct during the performance of his work. The men can, I believe, take up the shares of the company at par and partake of all the advantages of the company; and there are so many shareholders amongst the men in the employ of the company that they are now represented by a director. The workingmen have a director who sits with the other directors of the company. I may tell you that there is no doubt that the profit-sharing system connected with the South Metropolitan Gas Company has done a considerable amount of good in welding the men and the gas company together, and no doubt has done a great amount of good in connection with the company generally.

There is a feature in connection with the profit-sharing scheme that I would like to see carried out. Some men appear to be interested more than others, and if there are individuals employed on the works who may be profit-sharers, but not very industrious, they may interfere with the advantages of those who are profit-sharers and earnest workers; that is to say, a man may not exert himself overmuch and yet get his wages regularly; and after he becomes a shareholder

he may exert himself or not exert himself, but still he gets his dividend and interest when it becomes due. What I would like to see is that every individual man should take an interest in his work and be paid accordingly, the same as I do in my own works where I manufacture machinery. I think we should encourage every workman to take a special interest in any piece of work he is doing. In that case a man is given so much, according to the work he does; that is to say, you tell him, "I will give you ten shillings for doing that piece of work, and you can do it in as little time as you like." Suppose he is ordinarily allowed ten hours in which to do the work, if he does the work in seven hours he gets the same money as he would under the ordinary system where the work would require ten hours—he gets the same amount of money for three hours less work. In this way every individual gets an advantage in connection with the work he does, and if he is an especially skilled workman he secures an increase over the man who is not so skilled. If a man does not work, he does not earn the money. If a man does the work in half the time, he gets so much extra money in his pocket. Therefore, I think, if you can make this work to apply individually to each workman, it is better; but I do not see how you can make this system apply to each individual in a gas works.

Generally speaking, I would tell you that they think very highly of the practice in connection with the South Metropolitan Gas Works, and are advocating it all over; but there are few yet who have taken it up. Recently the Chester Gas Company took it up, and many others are considering the question. My own feeling is that there are some advantages in it, and a great advantage is that you can avoid strikes and prevent the commotion which has been taking place in this country. The reason this matter of profit-sharing was brought up was through the great strikes in England. We had some strikes some years ago in connection with the gas works where the men became very troublesome, and the whole thing was wrong from beginning to end. Our own and Sir George Livesey's feeling is that we could not manage our works properly if we did not have this piece-work system in operation.

Mr. Fred. H. Shelton (Philadelphia, Pa.) :—Mr. President: This is a "business session" primarily—the first session of this Association is apt to be considered the business session. I think there is one action which it is the business of this Association to do, which, as far as I know, has not been done, and that is to make some special record of its appreciation of the work of the Committee on Uniform Accounts. The Association, as we know, has accomplished something that we have tried to have completed for years. I recall within my time as a member of this Association that all efforts heretofore toward uniform accounting have failed completely—committees were appointed and reported, but their recommendations did not carry sufficient weight. They were not sufficiently complete and did not cover the ground. This Association, still appreciating the need of uniform accounts, some two years or more ago took a further hand at the problem and appointed a committee, as results have shown, competent to deal with the proposition. The evidence of the competency of that committee has been mailed you in the printed form of their report recently distributed. It is almost unnecessary to dwell upon the advantage of a standard system of accounting. We have something now that we may use in the future for comparison —the comparison of one gas company with another, the comparison of local questions that may arise, in examinations that may be necessary, and concerning which a standard, comprehensive and practicable form of accounting is of the utmost value. This has been accomplished by the work of Messrs. Humphreys, Lathrop and Lillie.

We have a good many committees, first and last, appointed by this Association, and they usually do very good work. They report, their work is appreciated and they are discharged. But I think the work of *this* committee is of so much greater importance than the average committee's work that it should receive special and greater appreciation and notice than ordinary on the part of this Association, and I am sure it is not only our business to so put ourselves on record, but our duty and our pleasure to especially express the appreciation of this Association of the work of the committee referred to. I do not know whether or not the committee has been discharged ;

but its work having been completed, I would like to see it discharged with the special appreciation of this Association going on our record.

In order that the matter may be presented formally for our record, I move an especial vote of thanks to Messrs. Humphreys, Lathrop and Lillie, for their particularly effective work in standardizing a system of accounts for the American Gas Light Association.

MR. W. L. COSGROVE (Atlanta, Ga.) :—In seconding the motion, I want to say that I think the most practicable way by which we can show our full appreciation of the work of the committee is by adopting the system. A good many of our members will adopt it in part, some *in toto*, and others will pass it along ; but we cannot come here and talk intelligently in the meetings, or outside of the meetings, without some such standard system of accounts, and I feel it is one of the greatest works this Association has ever turned out. I did not appreciate it fully at first and did not criticise it, as Mr. Humphreys requested, a year or so ago, but I fully appreciate it now and most heartily second Mr. Shelton's motion.

A MEMBER :—I would like to second this motion, and my object in rising is to say this—that it may be possible that the committee will have a feeling of disappointment at first at the reception of their report, but I do not think they need have any such feeling. They should realize that while companies cannot at once make changes of so radical a character in many cases as would be involved in adopting the standard system, yet it will be of great value and usefulness hereafter, as companies find they can make changes and turn to this system, and they will turn to this system as a guide for information. I think the value of this report will be appreciated, and seen more in the future than in the present.

Mr. Shelton's motion was unanimously carried.

THE PRESIDENT :—Gentlemen, it gives me the greatest pleasure to extend to you the thanks of the Association for this work, and I believe every member will do his best to reap the fruits of the work of the Committee on the Standard System of Accounts.

Mr. Alex. C. Humphreys (New York City) :—Mr. President and Gentlemen : I would like to acknowledge your vote of thanks, and to say it has been a great pleasure to every member of the committee to do this work. We regret that we were not able to put more time on it. I hope the members of the Association, if they do turn to our work for guidance and should find errors in detail, will regard them leniently and remember we have not had the opportunity to revise our work as thoroughly as we wished to do. I remember some years ago hearing one of my friends, a professor I was then working under, make a remark as to the difficulty of getting absolutely correct text books. He said that as far as he knew the only one which did not contain typographical errors was Trautwine's Handbook, and this degree of accuracy was the result of many yearly revisions. We can hardly hope that the first edition of our work will be found to include such a degree of correctness.

I would again like to remind the Association that others were actively connected with this work besides the committee, and they deserve to have their names finally recorded in connection with this vote of thanks. I refer to Messrs. E. L. Brundrett, Walter Elliott and G. W. Curran, Mr. Lillie's assistants. These gentlemen gave us much help in the detail work and made many suggestions of value. On behalf of the committee I gratefully acknowledge the Association's vote of thanks.

The President :—The time has now come to take a recess. The chair hopes that every member will be present punctually at 2:30 o'clock, so that we can take up the papers on the programme for the afternoon session.

FIRST DAY—SECOND SESSION.

The President called the meeting to order at 2:35 o'clock.

The President :—The first business this afternoon is the Report of the Committee on the Award of the Beal Medal. Mr. Walton Clark is Chairman of that Committee, I believe.

Mr. Clark presented the Report of the Committee as follows :

American Gas Light Association:

Your Committee to award the "Beal Medal" to the writer of the best paper presented at the 1902 meeting of the American Gas Light Association, appointed by the President, under authority of the Council, granted October 20, 1897, as follows:

"Mr. W. R. Beal having offered to present annually a gold medal to the writer of the most valuable paper presented at each meeting, the Council accepts the same with thanks, and recommends that it be known as the "Beal Medal," and be awarded by a committee of three appointed by the President from among the past presidents,"

respectfully reports that it has awarded this medal to Mr. I. N. Knapp, for his paper on "Notes on Cement Masonry."

WALTON CLARK, *Chairman*,
CHARLES H. NETTLETON,
C. J. R. HUMPHREYS,
Committee.

THE PRESIDENT:—Gentlemen, it gives me the greatest pleasure to present this medal to Mr. Knapp. I look upon that paper as a lasting contribution to our Proceedings.

MR. I. N. KNAPP (Ardmore, Pa.):—I thank you, Mr. President and Gentlemen of the Association, and appreciate very highly this medal.

THE PRESIDENT:—Gentlemen, the next order of business will be the reading of papers. The first paper will be on "Our Correspondence School," by Mr. Alexander C. Humphreys, of New York City.

(For paper see Appendix, page i.)

THE PRESIDENT:—Gentlemen, you have heard this very interesting and very important paper. I hope that you will discuss it freely. In this connection I wish to say that those in the rear of the room have experienced some difficulty in hearing. Will the members as they rise speak distinctly, so that the gentlemen in the rear of the room can hear; also on rising I should like the members to give their names and addresses to the stenographer.

The Secretary has some remarks from one of the members of the Class and he will read the same to you.

Mr. C. D. Robison (Auburn, N. Y.):—Being one of the members of the First Section of the Educational Class, I am deeply interested that the work of this Class be extended. When a young man finishes his high school work, what knowledge he has touches so many subjects, each one so superficially, that he has an idea it is impossible for him to acquire any knowledge of the technical side of his work. The text books on the subjects in which he is interested go so much into detail, and give so much information that is foreign to the work in which he is engaged, that he can see no connection and becomes discouraged. The effort to work by himself, without any encouragement, is so great that he soon becomes absolutely discouraged, and gives up the hope of acquiring any information on these matters. To men who have had this experience, the Educational Class of the American Gas Light Association comes as a Godsend. The questions given by the Trustees apply directly to the work in hand, and require the reading of books that are of practical interest to the student. A superficial examination of the papers would lead any one to believe that there is small work on them to require three years; but in answering the questions intelligently it is necessary to read parts of treatises on masonry construction, heat and several works on chemistry and physics, both elementary and advanced, and the files of both the *Journal* and *Progressive Age*.

The questions are put in such a way that the practical application of the information asked for is very evident. This gives the student an incentive to keep at it, which is necessary where a man works all day and is obliged to do his studying at night.

The assistance of the Secretary is of inestimable value. In my own work I feel the greatest gratitude to him for the universal courtesy and encouragement which he gave me in my work. The personal factor which enters so largely into college instruction, and which is so lacking in self-education, is very largely supplied by the Secretary's kind consideration, which is always extended to the students.

In regard to the practical results of this work, the value of the School is not so much derived from being able simply to answer the questions as it is from the intelligent interest it gives men in their work. A man who takes no interest in his work is of little value, and if he has no knowledge beyond that required to do the mechanical work he has in hand he will take no interest. A man who is working and thinking ahead of his present position is worth double to his employers what one is who is barely thinking enough to hold down the position in which he is at present engaged.

As a general thing, a college man has something better in view than a subordinate position, particularly in a small gas works, and if he is any good, by the time he begins to be of some use he pulls out ; while the men educated by the Class, having smaller ideas and opportunities, are more apt to stay with the smaller companies, and make very valuable men for them. The smaller companies are simply conserving their own interests when they encourage their men to enter the Class or contribute to its support. I would almost guarantee that most students would suggest some saving or improvement in the operation of any gas plant with which they chanced to be connected, during the three years' course, that would save their employers more than the cost of their tuition.

THE PRESIDENT :—That is a good indorsement from a student. Can we not hear from some of the members on the question ?

MR. ROBERT M. SEARLE (Mt. Vernon, N. Y.) :—I would like to add a word to the good work. I have the good fortune to have at our works a few young men who have entered the Class, and I can see, in the indirect way which Mr. Humphreys spoke of, the good it has done our Company. When these questions are sent out I am called on to furnish Trautwine's Handbook, Kent, Newbigging, Butterfield, *American Gas Light Journal*, *Progressive Age*, *Journal of Gas Lighting*, and works on Cement Masonry and periodicals, to find out the answers to the questions, and in reading these text books and journals I find that the students pick up other matter of perhaps a good deal more value than the answer to the

original question. I can see in the line of work they are doing they are carrying out something they have read in these books or periodicals, and it helps a great deal more in the indirect way than in the direct way of the good that comes from answering the questions.

Mr. Walton Clark (Philadelphia, Pa.) :—This is more or less a critical time in the life of this work. The Trustees are beginning their second period of five years, and on what will be done in the next five years will depend largely the life of the work we have undertaken. I have heard there is considerable criticism of the scheme. It is of the utmost value to the scheme that the criticism should come out, that we should know what it is, and give the opportunity to the subscribers of the School who are present to hear what our answer to the criticism is. We do not know all there is to know about education or about education through the medium of correspondence schools. We could probably get lots of good from adverse criticism. If there is to be any adverse criticism, I hope we will have it now and here, in order that we may, if possible, answer it satisfactorily, or, at any rate, have the benefit of the criticism.

The President :—Gentlemen, the testimony in regard to our Correspondence School seems to be pretty much all on one side. Is it not possible that some of you gentlemen have some objections to offer to our system, or some criticism, or some suggestion as to improvement? This is an experience meeting and we would like to hear it. It is possible that we all agree that this Class is just as good as it ought to be or can be made. If there are no remarks on the other side, we will hear some more testimony in the same direction from Mr. Forstall.

Mr. A. E. Forstall (Montclair, N. J.) :—I think I can suggest an improvement. But before reading what I have written, I want to make my position in the matter clearly understood. You must listen to what I am going to read understanding clearly that I will not be the man who will have the position when the salary of the instructor is raised to pay for the whole of his time. I am not trying to get a

higher salary for myself. I want that clearly understood so that you will not think that I am interested, from a financial point of view, in what I am saying.

In discussing the subject covered by Mr. Humphreys' paper I propose to treat of the possibilities of the work carried on by the Trustees Gas Educational Fund rather than of what has been accomplished in the past, because, no matter what the past, unless there is good prospect of usefulness in the future there is no argument to urge for a continuance of the Practical Class.

While it is not at all necessary to prove to the members of this Association the dollars and cents value of education, it may not be out of the way to remind you of it. Let us look at the subject of generator firing of retort benches as an instance. There is no question that, properly handled, generator furnaces, and especially generator furnaces to which are added efficient recuperators, are a great economic advance over direct fire furnaces, and yet several of the earlier installations were condemned simply because by reason of ignorance in the retort house they were not properly handled, and even now the same ignorance often prevents the obtaining of the best results. No man can make a success of generator firing unless he understands clearly what are the principles underlying it. These principles and their application are simple and can be easily taught to the retort house foreman, but until he learns them, he cannot be expected to know that, within certain limits, the cooler the fire in the furnace the hotter the setting and that increasing the draft may decrease the heat of the retorts and will certainly increase the fuel consumption. The difference between a knowledge of the theory of generator firing on the part of the man in charge of the retort house and no such knowledge, may easily be a difference of 20% in the make per retort and of 25% in the amount of fuel used, and you can figure for yourselves what this means in good, hard cash.

In addition to the advantages to be gained from the practical application to specific operations of imparted knowledge of underlying principles, there are also great advantages to be derived from the training of an employee to think about

his work and the things he sees around him every day, and in this way to bring the knowledge that he already possesses to bear upon his daily task. As long as existing conditions are accepted as a matter of course and no thought is given to the reasons for them, there can be no improvement, but can there be any question as to the improved practical and economic results that would follow the asking and correct answering of the question "Why do I do this in this way?" by every employee of a gas company, from the president down, every time he performed any duty. Everyone of us is inclined to accept things as we find them, simply because we have not been thoroughly trained to make certain that we really understand what we are doing and why we are doing it in a particular manner. Frequently, however, only a little thought is necessary to make us see that there are better ways of going to work, or possibly, that there is absolutely nothing to be gained by what we are doing. The cash value to the employer of an education that promotes a laudable inquisitiveness on the part of the employee can easily be appreciated by a little consideration.

With so much by way of a reminder that the proper education of employees will represent value received to the employer, the question "Can the Practical Class give such an education?" is now to be taken up.

The ideal education is unquestionably that derived by a very small number of students from an instructor who knows each of them thoroughly, through intimate association, and can thus suit his instruction to the individual needs. The ideal is, however, proverbially difficult of attainment, and in technical education is practically never reached. In the gas business, ideal education is only possible in the comparatively rare positions where the subordinate with the desire to learn has a superior with the ability and the willingness to teach. The nearest approach to this would be a class with the freedom of all departments of a gas company's business under an instructor fully qualified by a combined theoretical and practical knowledge of the subject. Membership in such a class is, however, necessarily limited to residents of the particular locality or its immediate vicinity, or to those who can

afford to live away from home and devote all their energies for a given time to the acquirement of their education. The Practical Class was started and is carried on to meet the wants of those who, though anxious to learn, could only do so while earning their living by work in positions such that it would be impossible for them to take vacations of any length without loss of income and even of position.

Such men cannot come to the instructor and are too widely scattered to make it possible for the instructor to go to them, and nothing remains but instruction by correspondence. In teaching by correspondence it is not a matter of any great difficulty to set forth clearly the principles and facts that should be learned, but it is hard to make certain that they are learned in such a way that the student can at any time give a reason for the faith that is in him and still more difficult to establish habits of inquisitiveness in the members of the Class. With some these objects can never be obtained, just as some never derive any great benefit from even individual instruction, but in many other cases the student can be made a well-informed and reasoning gas man.

This is done to a certain extent in the Practical Class by the character of many of the questions given, which, following a suggestion made by Mr. Alex. C. Humphreys when the Educational Committee was first organized, are designed to make the students think about the things that they see about them every day. But the process can be completed only by the meeting by the instructor of the individual wants of each man. To enable these to be known it is necessary that the instructor have time to study the requirements of each individual, and that the answers and letters of the students be such as to show their several needs. The man who puts something of himself into his answers and asks questions, in addition to answering those sent him, gives to the instructor a knowledge of his requirements that enables them to be fully met, and such a man derives the greatest possible benefit from the course. But if every member of the Class were to do this, no one person could take care of a class of its present size even though devoting all his time and energies to the task, and still less could it be done under the present conditions of

income which do not permit of securing the full time of an instructor qualified for the position.

The experience of the past five years seems to show that the average number in the Class will be about 100. Four sets of twelve questions are sent to each of the three sections each year, making a total of 144 questions per year. The preparation of the answer to each new question will require on an average one day, even when no drawings are required. If half the questions are new, seventy-two days will be required for the preparation of answers to them, leaving, with no allowance for vacation, only 228 working days in which to study and attempt to meet the requirements of 100 separate individuals, or an average of 2 1/4 days per man per year or only a little over one-half day per man per set of questions. As a matter of fact, the correspondence connected with the handling of the subscriptions and the enrollment of new members, and the general work of carrying on the Class will cut off more than the odd 28 days, leaving less than one-half day per man per set of questions. That is surely not an exorbitant amount of time to be devoted to each student if the best results are to be obtained.

To secure the full benefit that may be derived by the gas industry of this country from the Educational Fund, the annual income should be increased to an amount that will make it possible to pay to the instructor the salary that the position is worth and to also pay all office rent and for all the clerical assistance that is required to carry on the work of the Class. This would call for an income at least $1,000 per year greater than it has been during the period just ended.

In my position I have been able to observe the eagerness and gratefulness with which the opportunity afforded by the Practical Class is grasped, the earnestness with which the work is carried on, and the amount of benefit derived from it by those who take full advantage of its opportunities. As an example of the benefit derived I may instance the case of one of the students who in 1899 was a boy-of-all-work in a gas works, and is now in charge of the works and the laying of street mains for a company selling fully 30,000,000 cubic feet per year, and that of another boy who, starting as store-room

boy, has also become a works' manager. These cases occur to me because I knew the boys and put them in the Class, and not because they are the only ones of the kind. Having seen the good that has been done even under the part time arrangement existing at present, I can realize the greater good that might be done under improved conditions, and I most earnestly hope that the members of this Association and all interested in the gas business will by their subscriptions make it possible for the work to be carried forward to its full development.

Mr. Charles H. Nettleton (Derby, Conn.) :—Mr. President and Gentlemen : I cannot say very much, but I do want to express my obligation to Mr. Humphreys for preparing this paper. He has expressed in detail, and very completely, the thoughts which have been running through my mind in connection with this matter. I have believed in this educational class work from the very beginning, and in a modest way have contributed to it, my only regret being that I could not contribute more. It seems to me that it does much for us who have charge of gas companies, and a great deal more for the men who take the course. As Mr. Humphreys says, the work of the School is practical and gets directly to the subject. If you stop to think for a moment, particularly the older men in the room who were in the gas business twenty-five and thirty years ago, and notice the tremendous change in our Association—its meetings, papers, methods, I think you will agree that the change is for the better, and that it is due largely—not entirely—but largely to our technical schools. Our Correspondence School does not take the place of the technical schools, but it is giving some of our young men a training they can get in no other way, and, consequently, must help our business along the same lines that it has been helped by the scientific schools. As Mr. Clark so nicely expressed it years ago when doing this educational work, largely alone, simply as a labor of love, he said, "I want to give the boys a chance," that is the thing that has appealed to many of us in supporting this School. We are doing, so far as I know, that which no other association of

this sort in the world is doing, and as I think of it, it makes me glad and proud that I am a member of the American Gas Light Association.

Mr. R. B. Brown (Milwaukee, Wis.):—I do not think I can add anything to what has been so ably said by the gentlemen who preceded me on this subject; but I would like to go on record as being thoroughly in accord with Mr. Humphreys' statements, and as one who, I think, knows by experience the benefits which may be obtained from this School. I have had from the very first to do with men who were obtaining the advantages of membership in this Class, and while I cannot say that all of them appreciated the advantages to the full, at the same time we have had enough thoroughly good men out of it to pay for all the effort and expenditure which has been made.

There is one point I think some of the members do not appreciate to the full, and that is that this class work teaches the men to help themselves. The average technically educated man knows where to go to get help. He knows the use of reference books and text books and all sorts of publications which are in print on subjects he may not be familiar with, and thus he knows how to get the information. But the average man that this work is designed for knows nothing about such aids and is perhaps diffident about asking questions of his superiors; and perhaps some of his superiors, through being too busy, do not pay enough attention to the questions that *are* asked of them by him, and he becomes discouraged and drifts along. This work teaches a man that he can help himself, and I find that is a very valuable feature. Our men are patronizing our extremely good public library in Milwaukee, and I have been much surprised from time to time to see the number of technical books which are added to the library through applications from our own men. It shows they are not only following up the work of the School, but are taking so active an interest in the general subjects brought up by the School as to read further on technical subjects in general.

Mr. John West (Manchester, England):—I would make a few remarks and tell you what we are doing in Old England. We take a deep interest in technical education and education

generally. Gas men in England have not taken up this question as a body. There is an old London guild who have gas examinations; but the young men who seek to pass these examinations have to study at home without much assistance, study books, and if they want to know something special they must write to some of their gas friends to get information. There is no systematic way of getting information. Perhaps they may write to one man and he will help them, and they may write to another man and he does not help them as they would wish. I presume, as far as that is concerned, it is the same way in America as in England.

We cannot get the young men fully equipped for the positions they are to take up. They may be technically trained, but do not know much about the gas industry, and before they are of much use to us we have to educate them ourselves. We want something more than that; especially as we get old we want someone to prop us up. Therefore, it seems to me that this idea of the Correspondence School must be a very great thing in your country, where the distances are so great that you cannot meet together very often, and you can only get the information in this way by mail, and in order to do that successfully you must have a thoroughly qualified man who can receive the questions and answer them correctly.

Therefore, I say to you, it is incumbent on you to accept Mr. Humphreys' proposition and give him any amount of money he wants to carry on this work. It is a great work. You are investing money for a great object, and you will get something in return. In Manchester, where I live, we have something which you cannot have. I may tell you that within an area of forty miles around Manchester we take in a large number of reasonably large towns—within forty miles from the centre of Manchester we have a larger population than the city of London. That population is about six millions. In Manchester we have fine technical schools. We paid £300,000 for the building of the school house and for some time past we have had classes in connection with the gas industry and general instruction on gas subjects given to the students. The man appointed at the head of this class is a chemist, a practical man in connection with the gas industry.

They have sessions of the class two or three times during the week, and they generally arrange to hold one of the sessions on Saturday. We are not supposed to do any work after 12 o'clock on Saturday. These young men, our assistants, come into Manchester from all the parts around, some coming ten, fifteen, and even twenty-five miles. They have that advantage in Manchester, which you could not have because of your distances in this country. There is a course of study for one term, and the best man they can get from the technical schools, a practical gas man—one of my own chemists was the teacher last year—and we are trying to give the young men a thorough and complete course in gas manufacture. I insist on the young men about me going to that class, and there is no assistant within an area of twenty-five miles but who attends this class. The gas engineers want the young men to attend and see that they go to it. You can depend upon it they get a great amount of good if they attend the class. They won't get through unless they are technically trained, and the students want to get a lot of information. We want to make them ambitious and secure the special training we want them to get to serve our purpose, so that they will understand what to do when we tell them of the things that are to be done. I advise you to exercise all the influence you can bring to bear on the young men to secure their participation in this course, and to assist them in their efforts as far as you can possibly do so. I have instructed some of our young men—it is a pleasure to give information to the thirsty young fellows who desire to drink of the waters of knowledge that you can give them.

Mr. James Somerville (Indianapolis, Ind.) :—I would like it to go on record that because some of us are not able to contribute very much to that most worthy object we have heard about this afternoon, it must not be assumed that we have not done anything for the young men. I see before me men who have thought it a great pleasure, just as soon as young men about the works have shown any desire at all to rise, to give them all the assistance possible. I do not like to speak about myself, but I have in mind a good many boys, occupying

responsible positions now, that I have sent out, and I see men around me who have done the same thing. It is a great pleasure now to have these men come up and shake hands with us. What I wish chiefly to say is this—since this movement has been inaugurated the first thing I have told these men was to join the Correspondence School. I tell them that is the first thing to do. Like my friend here, I have taken these questions and found a great benefit in trying to answer them —a great many I could not answer, I acknowledge. But it has been a very interesting matter to talk these questions and answers over with the young men who have shown a desire for advancement; and, as Mr. West says, it is a great pleasure to assist and help any young man; and I would like these young men to know that if there is any desire on their part to rise let them go to the superintendent and I know he will help them.

A Member:—I do not know of any work, Mr. President, that this Association has in hand which is quite so important. In the contact I have had with the men who have been taking the course, I have been more than pleased to note that this Correspondence Course is filling a want that was never filled before. One thing that has gratified me particularly has been to note in several instances, upon the part of those who have been identified with this work, that it has aroused an interest in the works end of the business. That to me has been very gratifying.

Mr. Walton Clark (Philadelphia, Pa.):—Mr. President and Gentlemen: This unanimity of opinion in favor of the work of the Trustees is very gratifying. Such unanimity was hardly to be expected from a study of the subscription list, and I prepared answers to certain objections, criticisms and inquiries that might be made; but I notice that I am up against men of straw, so I will not read them. I feel very much gratified at the expressions of approval of our work, and I can say for the Trustees that they will all be gratified with the discussions we have had here this afternoon in connection with this work.

THE PRESIDENT :—Would it not be well for the answers to be read as a matter of record ? They might start up someone to speak on the other side of the proposition.

Mr. Clark presented the following :

It is known to you that I am and have been interested in the work of the Correspondence School. The part that I have taken in this work has been so great a pleasure to me that I am not able to flatter myself that Mr. Humphreys' kind suggestion of unselfishness is deserved. Our work reaches a class that never before has had, and that without your subscriptions never would have, either the education we give them, or its equivalent. Our students cannot go to college, they must be earning a living for themselves, and, in many instances, for their dependent families. They are mostly men of little education. Many of them do not know how to study on their own account, and a part of our task is to teach them how to study. Correspondence schools, as I understand them, ordinarily teach a class practically as a whole, and they are run for the profit they can earn. The highest degree of success in our work will never be attained by a man who is working only for the money there is in it. Our students need the guidance of a man who has been through their experiences, knows their work and has at least a little of the missionary spirit. Such a man may teach them many things not heretofore set out in the literature of the profession. That we do our peculiar work more thoroughly than other correspondence schools could or would do it is, I think, highly probable. Certainly we do our work better than do other correspondence schools, as far as they have come under my observation. I have recently had occasion to read the questions and answers on gas manufacture of a well-known correspondence school. The inadequacy of these to the needs of the student cannot be better illustrated than by saying that in this case there was no description given of the operation of an exhauster, a station meter or a governor. A cut, showing the exterior of each of these, was presented, and a statement made as to its function ; but its internal structure and method of operation were ignored. Going back to my own early days in a gas works, I remember that each of these pieces of apparatus was a mys-

tery to me, and that I arrived at a knowledge of them after much time and labor and considerable explanation. I could see the outside of each of them; but the inside was a closed book to me. I was so fortunate as to be under a man who was determined that I should know these things, and he helped me largely. There are many men in the business who are not so favorably located and who cannot learn these things without assistance from us or from some other correspondence school, or by the slow, and, to your companies, expensive methods of the school of experience. I ask you, if you are in any doubt as to the value of our explanations, to read the description of the construction and operation of an exhauster, on page 76, Vol. XVII, of the Proceedings of the Association; of a street main governor, on page 26, Vol. XV, and page 84, Vol. XIX, and of a station meter, on pages 32 and 41, Vol. XIV. I select these as being devices particularly difficult of description. I have been more or less a reader of books on gas industry for thirty years, and I do not hesitate to say that there is nothing in the English literature of our industry as clear and as well adapted to the understanding of the educated, or the uneducated, mind, as the descriptions of apparati and their operation as given in the answers of your Trustees to the questions of the Practical Class. It is not surprising that this is so. Many of these answers are the work of days. They are written by men familiar with the business—men who have seen, dismantled, repaired, and singed their hair and barked their knuckles in operating the types of apparatus described; and they are subjected, before issuing, to the criticism of other men, similarly acquainted with the machinery of gas manufacture and distribution. So good do I regard these questions and answers that I use them in my business. We refer to them in my office, and I have kept copies for those of my sons who are expecting to enter the engineering profession. With a full appreciation of the ability and attainments of the members of the American Gas Light Association, I say to you that none of you can fail to benefit from reading the questions and answers which your Trustees send out to the members of the Practical Class.

The work of educating men engaged in the humbler posi-

tions in the business of manufacture and distribution of gas is carried on in Europe on lines very different from those which we believe are best adapted to our conditions. In England, as you know, there are the examinations of the City and Guilds of London Institute. There is no attempt made at education, but the Institute will examine such applicants as present themselves, and will award certificates in two classes—the ordinary grade and the honor grade.

This is a very useful work, and I have derived great benefit personally from taking these questions, as they appeared in the *Journal of Gas Lighting*, and endeavoring to answer them. But, as you observe, there is no effort at education. It is simply a test of knowledge. That this work is not satisfactory to those who carry it on, nor to the gas men of England in general, is pretty well evidenced by an editorial in the *Journal of Gas Lighting* of Oct. 30, 1900, from which I take the following scattered extracts :

"Through almost all the examiners' reports there runs the same line of criticism, which points to the probability that the institute is not getting at the right order of learners. Many candidates for all sorts of examinations are clearly certificate hunters, whose object is to equip themselves with as many of these fallacious testimonials as they can obtain by 'getting up the subject.'"

"Over and over again the examiners complain that the real workmen entirely fail to show an intelligent appreciation of the science of their craft; other candidates who are good at the paper work are complete failures as workmen."

"So far as instruction in the elements of gas manufacture is concerned, the record does not compare favorably with the American work to this purpose."

These adverse criticisms cannot apply to our work, for we do reach the real workmen. One must be a workman in order to be a member of the Class. It is obvious that a system of instruction such as we have inaugurated, with your authority, is much better than the simple test of knowledge which the Institute undertakes, although that in itself is valuable.

In France there is no regular instruction for students desiring a knowledge of the gas business. The only instance of

any course in this line known to me is in conjunction with the technical school at Lyons, where day and evening classes are held. The lectures in this school are given at night, and, of course, are available only to residents of Lyons and its vicinity.

Considerable attention has been given of late to the special instruction of gas-works workmen in Germany, and a committee on this subject has been appointed by the German Association of Gas and Water Engineers. There are in Germany at least five institutions or enterprises for giving this instruction. First—A four or five year course at the technical high school in Karlsruhe, for the education of gas engineers. This is a fine work for men who are able to give the time and stand the expense of residence at the location of the school.

Second—There is a course of lectures at the same place, under the auspices of Dr. Bunte and others, for men employed in a technical capacity in gas works. These lectures were begun in '98, and relate chiefly to gas chemistry, and are attended mostly by chemists and engineers employed in the local works. It is probable that this work is highly beneficial to those whose circumstances permit them to attend. But such a system would not be at all applicable to the class which is reached by our school.

Third—There was established at the Dessau Gas Works a course of instruction, extending over two years, for the benefit of students or employees aspiring to the position of superintendent or foreman. This course is a private enterprise, conducted by the German Continental Gas Company, which controls the Dessau Gas Works, and is primarily intended to provide the company's need of foremen.

Fourth—A private enterprise, chiefly to instruct in gas fitting, was started in the town of Stolp. It was not a correspondence school and a fee was charged.

Fifth—In Bremen there was inaugurated in 1902 a course of instruction for gas superintendents and foremen, comprising three months' tuition, partly at a technical school and partly at the gas works. I have very little information as to this course.

The correspondence system of instruction in the gas industry does not at all exist, as far as I am informed, in Germany. I do not know of any country in which a system of instruction such as you have inaugurated prevails. None of the schools above described would meet our conditions, or do the work that the Trustees are endeavoring to accomplish.

This work is well worth while, whether we regard it as a philanthropic measure or as a commercial venture. I believe that we are broadening and strengthening the foundation upon which the conduct of our industry must rest when we broaden the minds of the men who occupy the subordinate positions in gas works. The work of the Trustees does more than merely instruct these men in the construction and operation of the plants with which they are connected. It teaches them how to study; how to use books, to think clearly and how to express their thoughts on paper, while it is making them more serviceable and contented employees of the companies for which they work. The interests with which I am connected have means of educating their own employees. Also we encourage our men to enter the Practical Class—many of them are members, and we so far appreciate the value to the industry of insuring that the men who are occupying humble positions in gas works other than our own, shall be broadened in their knowledge and understanding, and so far believe that the method adopted by the Correspondence School will accomplish this end, that we are and have been from the beginning a large contributor to the Trustees' Fund. In making this contribution, as employees, we believe we are doing our duty to our stockholders, who look only for dividends. As individuals we are gratified to believe that this once, at least, business and philanthropy travel the same road, and that our contribution is aiding in the work of broadening men's minds and letting in light to dark places, and so helping on the good work of elevating the mental and moral tone of our associates in the ranks of the gas industry.

The President:—Gentlemen, is there anything further to be said on this subject? If not, we will hear from Mr. Humphreys in closing the discussion.

Mr. Alex. C. Humphreys (New York City) : — There seems very little left for me to say. Unless there were objections to be met, I felt that the Report of the Trustees and my paper would sufficiently cover the subject; if there were objections to be met, I hoped to get the questions well threshed out in the discussion. I am a believer in frank statements of differences of opinion. Knowing there were differences of opinion in regard to this work in the Association, I had hoped that those who objected to our scheme or to our methods would frankly state their objections. Members are at liberty to do so, have the right to do so, and should do so. Possibly there are no such members here ; perhaps they have all remained away from the meeting. It would certainly be a great gratification to me personally to find there was a practical unanimity of opinion, as would be indicated by this one-sided discussion.

I am glad to hear from our friend Mr. West as to what they are doing in Manchester. I have recently been in contact with the Commission of Educators from his country, who are visiting this country under the guidance of Mr. Mosely. The branch of the Committee interested in my work called on me at Stevens Institute to see some of our technical methods. They did not seem to think we could teach them much on the purely technical side of education. It is true they have well equipped technical schools, but I do not think their courses of study are so well co-ordinated as are ours. We in America in our teaching better combine theory and practice, and especially at Stevens is this feature prominent. These Commissioners were particularly interested in such of our work as appeared to have a direct connection with engineering practice. They asked if I knew anything about correspondence schools. I gave them such information as I had about correspondence schools in general, and I more fully explained the working of our Gas Correspondence School. They wanted to know how they could find out more about it, and I gave them copies of the paper I have just presented. The question suggested itself at once to the mind of one of the members of the Commission, after I explained that I had taken up this work long before I thought of becoming a professional educator, whether

there was any change in my opinion regarding the efficiency of the Correspondence School work due to the change in my point of view now that I had become the head of a technical college. I told them I had not changed my views. I told them the work of the Institute and the work of the Correspondence School necessarily differed as to their aims and their methods. After discussing the subject with me further, they expressed the greatest interest in this particular work, and I do not think there was any one thing they discussed with me with more interest. They wanted to know if I could give them an insight into how we carried on the actual work of instruction, so I arranged with Mr. Forstall to send them a set of the questions and answers. In a few days I got word from the Secretary of the Commission stating how sorry he was not to have been able to visit Stevens Institute with the others, and asking me if I could send him a set of the papers relating to our Correspondence School.

Here is a commission of men who have been sent from abroad for the special purpose of investigating our methods, not only in technical education, but general education, to find out why our people are generally so well educated; they expressed but limited interest in our strictly technical work, but when I had anything to say about some of the other things that underlie our work—primary education, secondary education, industrial school education, and various forms of special education, such as by correspondence methods—then they were on the alert at once.

I would like to say to those of our members who come in contact with the students in this Correspondence School—do not be in a hurry to condemn them for what you think are deficiencies in their education, and especially do not be in a hurry to condemn the School because you may find some one individual man who is not efficient. Education sometimes fails. We can give men education, but we cannot make them efficient workers. There is a better chance for a man becoming an efficient worker through education, but there must be failures. We do not guarantee that every man who is turned out of the Correspondence School will be an efficient worker —such a guarantee would be ridiculous. The fact that there

are some failures applies not only to correspondence schools, but to colleges and universities.

In regard to the question of salary of the Secretary, it may strike you, and especially those familiar with the rates paid to professors in colleges, that Mr. Forstall is making an argument for a large salary to be paid to his successor. Stop to think what the position demands. A professor in a college is, as a rule, required to be a strong man in one department only. In a college, to do Mr. Forstall's work, you would have not one man, but a corps of men. I believe, however, that the work for a small class like ours can be better co-ordinated by having one man capable of carrying on the whole work. This means we must have a man scientifically educated and qualified through actual experience to direct the course along practical lines. This is more than we expect from most professors, who work as a rule in one department only.

I would like to express my agreement with the opinion voiced by two or three here—Mr. Clark, the Secretary and some of the others—that there are none of us in the Association but could receive benefit from the study of these questions and answers. We forget things ; our stored knowledge gets overlaid or rusty ; the things we have learned slip away from us. If I had to look up some detailed question in gas engineering in which I had grown rusty, I would go to these questions and answers. In the case of our Stevens graduates it is my purpose in the case of any who announce a purpose of going into the gas business to say to them, If possible, get a complete set of these questions and answers and study them carefully.

The President :—I wish to thank Mr. Humphreys, in the name of the Association, for the very interesting paper he has presented to us on the subject of our Correspondence School.

The next paper on the programme is that by Mr. Arthur G. Glasgow, of London, England, on "The Policy of Gas Enrichment (Illustrated by London Practice)." I regret very much to say that Mr. Glasgow has been unable to attend this meeting through a very severe illness. Mr. Humphreys

has very kindly volunteered to read the paper and answer any questions in connection with it.

Mr. Alex. C. Humphreys :—Before reading the paper I want to state that Mr. Glasgow particularly wished that I should express for him his deep regret at his inability to be present. He came over from England especially to attend this meeting. He got on board ship quite weak, threatened with nervous prostration; he was taken ill on board, and is now in a dangerous condition. He wanted me to express as well as I could to you his greetings and to say how much he regretted his enforced absence.

The President has announced that I would read the paper and answer any questions. I cannot promise that I shall be able to answer all questions. I will endeavor to do so, but that I can answer them as completely as Mr. Glasgow would, cannot be expected. He is saturated with this subject and has worked on it for a year. He has, as many of you know, been for months carrying on, through the columns of the *Journal of Gas Lighting*, a correspondence on this subject. While a number have attacked his position, I venture to say that anyone competent to the task who will study the correspondence in full will conclude that Mr. Glasgow has maintained his point.

(For paper see Appendix, page xi.)

The President :—Gentlemen, you have heard this very interesting paper by Mr. Glasgow. We all very much regret that he is not here with us, but we do not want to cut short any discussion on that account. We should rather discuss it more freely, because we all know he would like to have it discussed. Mr. Humphreys will take the floor in reply. The subject is now open to you, gentlemen. Mr. West, will you speak?

Mr. John West (Manchester, England) :—I would first like to hear some of the brethren in America say something on the subject.

The President :—Mr. Norris, will you speak on the subject?

MR. ROLLIN NORRIS (Philadelphia, Pa.) :—I do not know that I have anything to say just now.

THE PRESIDENT :—Can we hear from Mr. Doherty ?

MR. HENRY L. DOHERTY (New York City) :—I did not read the paper in time to prepare for a discussion upon it, and I am totally unprepared to talk on the subject. I do want to say, however, that we have in that paper a very severe arraignment of many men who are not here to defend themselves, and I think a spirit of American fairness should guide us in our discussions. I am in sympathy with Mr. Glasgow in his ideas on a low candle-power gas, but I cannot agree with him in all he says—we might have to condemn the action of many of our English brother engineers.

MR. J. ARNOLD NORCROSS (New Haven, Conn.) :—I would like to take exception to only one sentence in the paper at the bottom of page xxxix : " It is scarcely necessary to refer to the foolish attempts *to dilute coal gas* by the admixture of blue (or lightly carburetted) water gas." I think it *is* necessary to refer to them. There seems to be a movement growing in America, and the authority on which it is based is European. The papers and statements in support of it are by distinguished men, whose names are familiar here and are, consequently, relied upon. But I think if any impartial man will study this paper and read the articles referred to in it on Flame Luminosity and Blue Water-Gas, in the *Journal of Gas Lighting*, by this same author, he cannot fail to agree with the conclusions of Mr. Glasgow's papers.

It may be useful to call attention to the origin of the movement to utilize blue water-gas for town supply and benzol for enrichment. The movement started in a practical way in Germany. In Germany the native coal gives poor candle-power, poor yield and poor coke. In order to get good results they are obliged to buy English coal and pay a high price for it. Oil was, up to a short time ago, subject to an import duty of 100 per cent. The new Customs Law has increased it. Practically, the duty on gas oil was prohibitive. Consequently, the use of carburetted water-gas was almost shut out. On the other hand, benzol was a domestic product, handy and cheap,

and naturally there was a temptation to use it for gas enrichment. Another important point in connection with the German situation was the candle-power. It would be difficult to find a town in Germany which was supplied with gas of over 13.5 candle-power in our measurements, and more often it would be between 10 and 11 candle-power. These are conditions which do not obtain in England, and much less obtain here—far from it. When the price of coal in England went up a few years ago, the Germans were reduced to severe straits to make any kind of gas, not a question of making the best gas, but of maintaining a supply of any kind of gas. They fully realized that the use of blue-gas and benzol was but a poor makeshift. They were so well aware of that fact that the German Gas Light Association, the National Association, in 1901 sent a petition to the National Government praying them to lighten the duties on gas oil for the purpose of municipal gas manufacture, in order to remove the existing burdens and restrictions from the manufacture of gas, and to allow of the more general use of carburetted water-gas. Dr. Bunte was one of the signatories to that petition, and yet his name is often quoted in support of arguments toward reducing the candle-power and dilution by blue-gas.

The movement spread in England largely through the efforts of Prof. Vivian B. Lewes. He visited Germany when the blue water-gas plants were first started for town gas supply, and came back enthusiastic. He wrote a number of papers on the subject, and they were not subjected to the severe criticism which they deserved. The paper which he read at the Gas Congress at the Glasgow Exhibition in the Fall of 1901 created a sensation. It dealt with his introduction of blue-gas into the hydraulic main or into the coal-gas retorts, with the idea in view of possibly, by means of blue-gas as a carrier, retaining hydrocarbons in the gas which would otherwise be deposited in the retort or main. Later (see *Journal of Gas Lighting*, Dec. 9, 1902, pp. 1543-48) he repeated many of these figures and statements in a lecture before the Society of Arts, London. He claimed a gain of over twenty per cent. in heating value by the addition of the blue gas. He also stated that he got a gain of over twenty per cent. in

illuminating values. I had occasion to study into these figures carefully—it seemed so marvellous that by merely admitting blue gas into a retort you could get twenty per cent. gain in heating and lighting power as compared with a simple mixture of the two gases after manufacture. In the first experiment he added 29.5 volumes of blue gas of a net heating value of 73.4 calories per cubic foot to 70.5 volumes of coal gas of 138.8 calories per cubic foot. Now, by direct arithmetical calculation, the resultant mixture would have a net heating value of 119 calories per cubic foot. Prof. Lewes stated, both in tabulating the experiment and later on, that there was a gain of twenty per cent. Turning, however, to the end of the experiment, it will be seen that the heating value of the mixture actually observed by Prof. Lewes by calorimeter was 117 calories. There was, therefore, no gain whatsoever in calorific power; but, on the contrary, there was a loss as compared with simple mixing.

The statement in regard to the illuminating power was more difficult to find an error in. The gain in lighting power was based on the assumption that the blue gas carried forward benzol and other vapors from the tar. If any had been thus carried forward, there must have followed a gain in heating power. But there was no gain in heating power. Therefore, no appreciable vapors were carried by the blue gas, and it follows logically that there could not have been a gain in lighting power.

In the same paper Prof. Lewes described difficulties in the testing of gas, and showed that merely changing the method of testing from using a 16 candle-power flame to burning at the standard rate of five cubic feet per hour altered the corrected candle power from 14 candle power to 11.5 candle power. Assuming 11.5 candle power to be the expected candle power, this simple change in testing gives an apparent gain of 22 per cent.

Mr. Rollin Norris (Philadelphia, Pa.):—Of course, the general proposition is true that any company which is supplying gas, which is all water gas or partly water gas, can reduce the cost of its product by reducing the candle power of

the gas sent out. Unless such reduction in candle power, however, enables the company to use a radically different process of manufacture which will effect a marked reduction in the cost of the gas, the amount that the price of gas can be reduced on account of this reduction in standard candle power is quite small. In other words, if the consumer gets the entire saving in the cost of the gas due to a reduction in candle power, this reduction in price would amount to only about two-thirds of a cent per candle power. If the candle power of the gas sent out were reduced five candles, which is an extreme amount, the reduction in the cost of manufacture would amount to only about three and one-third cents, which would not be a very material reduction of the selling price of the gas.

Of course, if there were some other process of gas manufacture which could make a low candle power gas at say twenty-five cents per thousand less than with present methods, there would be a strong argument in favor of lowering the quality of the gas supplied.

But, in general, the higher the candle power of the gas supplied, the more the consumer gets for his money if he pays the entire extra cost of the increased candle power.

Mr. Robert Young (Pittsburg, Pa.) :—I think only one thing can be said in favor of low candle, or low calorific power gas, and that is, it is much easier to get complete combustion, and that is where it shows up the difference in favor of low candle-power. With high candle-power and high calorific power it is a difficult job to get oxygen enough to combine with the gas to get complete combustion. I think all things taken into consideration, if the burners are suitable for high calorific power gas, the argument is in favor of the high candle-power as opposed to the low candle-power. I think the trouble between the two is in getting sufficiently complete combustion of the high candle-power to get the best results. Another thing has to be taken into consideration. The low calorific gas will require larger mains, services, meters and fittings to transport the same amount of energy from the point of production to the point of combustion.

Mr. Thomas Littlehales (Syracuse, N. Y.) :—I followed these tests of Dr. Lewes very closely, and, as I understood, the results of these tests made at the Crystal Palace Works were that by putting in 40% of blue water-gas, he increased his bulk that much, with the loss of 1½ candles. The claim was —and I think can be established to some extent, perhaps not wholly—that the blue water-gas becomes carburetted in the retort and in the hydraulic main by taking up the benzol and other vapors of the series of light hydrocarbons which would otherwise go to the tar-well. In other words, the blue water-gas put in becomes carburetted by the materials usually going into the tar-well. That is the position, as I understand it.

The President :—We would be pleased to hear from Mr. West on the paper.

Mr. John West (Manchester, England) :—Mr. President and Gentlemen : I have very much pleasure in taking part in this discussion, because it is connected with a subject in which I have taken a deep interest for the last thirty years. Only a short time ago, when I was in London, I had the pleasure of listening to the eloquence of our friend, Mr. Glasgow. I regret with you that through illness he is not here to-day. I had hoped to see him to-day, because I wanted to disagree with him. The last time I heard him I agreed with nearly all he said. I have listened carefully to this paper by Mr. Glasgow, and I agree with some of it, and some of it I do not agree with. I did not expect that he was coming across the water to thrash and ridicule we old Englishmen in the way he has done ; if I had, I should have prepared myself with a little powder and shot ready to throw a volley at him. But in reading the paper I do not find, after all, very much but what I think I can rectify. He has made some very great mistakes in his paper, and I will try to rectify them, and tell you my reasons for holding the opinion I do on the subject under discussion.

First, I will tell you that I have never said one word publicly either for or against carburetted water-gas. I will tell you, also, that under certain conditions I am a low-grade man, as you call us ; but not in all cases—it depends on the locality

and the materials to be carbonized. I would not use carburetted water-gas if I could do without it. I would use it if I thought it would be an advantage to me in giving more light and producing economy. I would not like to use it unless it could be proved that its adoption would result in economy.

As to the paper, it is called "Gas Enrichment, from a London Standpoint." A part of the title, I believe, has been altered to read "Illustrated by London Practice." Well, we will see. It is a very clever paper; and such as you would naturally expect from such a highly educated man as Mr. Glasgow. We all acknowledge his ability on the other side of the water and very much appreciate him. He has endeavored, no doubt, from his London standpoint, as he calls it, to make out a case. He first begins with the method of enrichment and says that cannel enrichment is generally played out; the candle is not worth the game. We used to be troubled many years ago when the illuminating power standards were increased to get cannel at a reasonable price, as the cannel coal proprietors kept sending up the prices, therefore many were glad when this carburetted gas enrichment system came out, and they readily adopted it where they could not very well do without it. We could not increase our cand e power without buying rich cannel at considerable cost; at the present time, however, large quantities of cannel are used.

As to "Vapor Enrichment," well, I know very little about it. I have never recommended it to anybody, and I do not know that I shall do so after what I have heard to-day. On page xv you will notice that some statements given by Sir George Livesey of London are quoted where he speaks about a fortnight's experiment being made with and without vapor enrichment in the South Metropolitan Gas Company's area of supply, and they found that gas which was enriched with the vapor did not travel very far. It was tested by the portable photometer, and the results were the same in both cases. Mr. Glasgow says: "The portable photometer results, although as an instrument it corresponds exactly with the official photometer, cannot be accepted as accurate because the instrument is used under improper conditions; still, when compared with itself under similar conditions the comparison holds

good." I want you to remember that statement. He says that the instrument cannot be accepted as accurate because it is used under improper conditions, and yet soon afterwards in the paper he takes up some statements that have been made by Dr. Frank Clowes, Chief Chemist and Superintending Gas Examiner to the London County Council, and there, as I understand it, he takes some special tests that were made with this improper photometer at certain places in London at certain consumers' houses, and says that the illuminating power he obtained with this improper photometer produced a light equal to 14.68 candles, whereas sixteen candles should have been supplied. It is unfair to assume that in the South Metropolitan District, less than sixteen candle standard gas was being supplied. It appears to me that Mr. Glasgow has tried—although he does not say so in so many words—to make you believe and understand that the South Metropolitan Gas Company was sending out gas of less candle power than they were compelled to send out by Act of Parliament. Now, what is the Act of Parliament—what are the conditions under which the South Metropolitan Gas Company were working? because it is assumed here that they should supply sixteen candle gas, when, according to the statements made by Dr. Clowes, it was only 14.68 by his special tests. The supplying of gas to the city of London is very unique and special, and it is necessary I should explain this to you before you can fully understand and appreciate the reasoning of this paper. It could be assumed here that all the testings that are made by the official testers are made on the gas works, but such is not the case. The London gas supply is under the direction of the Metropolitan Board of Works, who appoint three referees, men of eminence, who stand between the companies and the consumers, and these three gentlemen arrange for official testing stations to test the quality of the gas furnished by all the companies distributing the gas throughout the entire city. The gas is not often tested by the official testers at the gas works, but at official testing stations which are arranged and elaborately fitted up and marked out by the gas referees, so that they can test the quality of the gas in the various districts as it is being supplied to the customers. Some of these testing stations are

several miles away from the gas works. There are testing stations where the South Metropolitan gas is tested, nearly four miles from the gas works; and I think the assumption is created by this paper, rather Mr. Glasgow wants you to think or believe that the gas is sent out from the works vaporized before it is sent out, and that it does not reach the consumers of the prescribed sixteen candle standard. What are the facts of the case? These official examiners test the gas daily in all sections of London—there is an army of them, and they are very anxious indeed to find out if the gas is not of the prescribed quality, and they do not forget to report such a case if found out. They always report the gas if it is below the standard quality, and the gas companies are fined, and they do not like to be fined. What do these official examiners say? They say they have tested the gas supplied by the South Metropolitan Gas Company throughout the whole area of their district, and that they find it 16.58 candles. The test at gas works for the half year to June, 1901, was 16.77. The official tests at these official testing places, under the Companies Act of Parliament, is fully half a candle more than the company is compelled to give. What becomes, then, of the assumption and statement introduced here by Mr. Glasgow? I will tell you what we found when some of us gave evidence to try to get the candle power reduced. We found that Dr. Clowes and others had been testing gas at what I should call illegitimate places. They went with this peripatetic photometer to some out-of-the-way district, to the rooms of some school board and other places where the gas had not been burnt for some time, and they set up the photometer there and get what they call test gas. They went to these places probably because they would not expect to find gas of sixteen candle power, because it had been lying dormant in the mains for several days. Again we found that the gentlemen had been testing at the dead end of mains and found low results there, and these are the tests which Mr. Glasgow brings before you for comparison here. The South Metropolitan Gas Company have protested against this improper testing of their gas. I maintain that the South Metropolitan Gas Company has fulfilled every obligation to Parliament and to the public. No

gas in the country is more severely tested than that supplied by the London companies. They have all stood up to the mark and supplied the consumers with the prescribed standard quality of gas.

It is also stated on the same page (xvi) that Parliament "is justified in abolishing a system of enrichment whereby it is admitted that the consumer pays for goods that are not delivered." The official tests show that the goods were delivered throughout all the districts. Some of these test stations were a mile, two, three and four miles away from the gas works. What gas was the South Metropolitan Gas Company supplying? Not carburetted water-gas, but they were supplying chiefly, if not all, coal gas, and they had to sacrifice their volume. They had to sacrifice their volume for their quality. They obtained a low quantity per ton of coal to keep up their standard. I would like to ask Mr. Humphreys if he knows the calorific value of the gas that was supplied by the South Metropolitan Gas Company when they were under the obligation to give sixteen candle-power. It would have been well if Dr. Clowes had tested the calorific value and placed that beside his special illuminating power gas.

The conclusion, therefore, that I arrive at in connection with this question is that Mr. Glasgow has been somewhat misled by Dr. Clowes' statements.

There are other things I do not quite agree with, such as capital expenditure—but I do not want to go into that. I do not think I shall take up the question of space. I do not quite agree with that, because it is nothing unusual for us to put up a plant now making double the quantity of gas made on the same area formerly. I have seen works where there are only three or four retorts in a bed in this country, and we are now putting up ten retorts on the same space which do a great amount of work. The question of coke is perhaps an important one, but I do not know that I could draw the same conclusions my friend has made on that point, because that depends very much on the locality. I know works where it would pay to burn the coal to get the coke for sale. I am not sure that it would not pay in this country to do that. I understand that coke has fetched high prices in some of the dis-

tricts in America. Therefore, it depends on the locality. In some cases it is a great advantage for you to get as much coke as possible to sell. In the case of the South Metropolitan Gas Company, where they do not use carburetted water gas, the extra coke for sale does not trouble them. Only a few weeks ago I attended a meeting of Gas Engineers at their East Greenwich Gas Works, where they had no coke on the place, and they were taking up the roads that had formerly been put down, actually digging them up and washing the breeze, so as to get this breeze to sell, because there was such a demand for it.

Well, then, as to carburetted water-gas and the labor problem—machine work *versus* hand work. I do not agree with that. I do not agree with the position taken in reference to machine work; but I do not want to go into that question now. As to noxious products—I was not aware until I read this paper that noxious products were more vicious in ordinary coal gas than in carburetted water-gas.

Mr. Glasgow speaks about the products of combustion in connection with gas stoves. On page xxi he says that the products of combustion are important "especially in view of the increasing use of flueless gas stoves." I do not quite know what that means, but if you read it as it stands one is obliged to assume that manufacturers of gas stoves are making them without flues to carry off the products of combustion. I hope that is not so. Fifty years ago Mr. Thomas Sharpe advised that no stoves should be fixed without an outlet to carry off the products of combustion, either up the chimney or in some other way, so that the products of combustion would go out of doors. I fancy this statement in the paper is a mistake; but I would advise you gentlemen, if the manufacturers are doing that, not to fix a stove without having a proper outlet for the gases generated in it.

The cost of enrichment for producing these two candles is too elaborate for me to go into, and I have not the materials with me to enable me to go into that question; but I will endeavor to go into this when I get to the other side.

Coming to page xxv, it is stated there that "elaborate determinations have been made by numerous skilled observers of

the 16 candle-power gas as actually supplied by The Gas Light & Coke Company, compared with the same mixture reduced to a 14 candle-power standard, tested by the method prescribed for the 14 candle-power gas of the South Metropolitan and the Commercial Gas Companies. The following results, verified by the author, are taken as fairly representative. The 16 candle-power district gas and the special 14 candle-power gas consisted of two-thirds coal gas and one-third carburetted water-gas in each case." This result was obtained with the "C" Welsbach burner. Now, gentlemen, I confess I do not understand what these elaborate determinations mean. Perhaps Mr. Humphreys will elucidate it. Does he mean that he took gas from the supply of The Gas Light & Coke Company, 16 candle-power gas, and reduced it by some means to 14 candle-power gas, by diluting it in some way, or does he mean that he reduced it by calculation? Either one or the other, and I do not care which for my argument. Then he takes for comparison this 16 candle-power district gas and a special 14 candle-power gas which is composed of two-thirds coal gas and one-third carburetted water-gas. I know of no such mixture as 14 candle-power gas being composed of two-thirds coal-gas and one-third carburetted water-gas. I never heard of such a mixture before. That is not the mixture we make from our Newcastle and Durham coal. That is not the mixture that Mr. Livesey is making and supplying in London to-day. Then why make comparisons with this special stuff? I do not know why it is made, except it is made so as to be compared against a gas which nobody knows anything about on the other side of the water. I confess I do not know anything about it; never heard of such a mixture before. And yet all of the figures following through this paper are based on that paragraph. I contend that the fabric which has been built upon this foundation is unreal; that the whole of the figures are built upon a false foundation. If Mr. Glasgow wanted to compare the Gas Light & Coke Company's gas with the South Metropolitan Company's gas, why did he not test the South Metropolitan gas pure and simple? If he had done so he would not have found that special 14 candle mixture; he would

have found a solid coal gas, with a higher calorific value in it than he has given credit to the 14 candle special mixture. I know what the quality of the South Metropolitan gas is that is being supplied by the company. That is not it. Therefore, I would like to ask Mr. Humphreys if he will explain that paragraph, because I shall contend that the whole of his calculations, which appear to me to be based upon that paragraph, are inaccurate. No such gas is supplied on the other side of the water and therefore his basis of calculation is absolutely incorrect. Then he compares the flat flame burner and these other burners with this special mixture all the way through. Of course, all the calculations are all wrong.

"Burners and testing." I believe a very great deal that is said in connection with burners and testing. Mr. Glasgow has gone into that question very liberally and very scientifically. There is no doubt that there should be made a proper burner suitable for every kind of gas supplied; that is, a burner which gives the greatest amount of light according to the quality of the gas used. But, unfortunately, on the other side, parliamentary requirement comes in and upsets our plans. We cannot do sometimes as we would wish. We cannot do what we would like to do for the benefit of the consumers whom we serve. Of course, a great deal has been said about the mischievous evidence that was given from data which was obtained in Germany by Dr. Bunte, whom I had the pleasure of talking with about a month ago; but at the same time I may tell you I have seen none of these diagrams. I know nothing about them. I cannot argue for or against them; they must argue for themselves.

As to the Welsbach burner, I do profess to know a little about that, because I have taken a very great interest in that burner. I believe I was the first to test the Welsbach burner to see what difference there was in the light given from it with poor and rich gases. I made considerable experimental investigation on this question. When consulting engineer for the Plymouth Gas Company I desired to test these burners, but I had some difficulty in getting mantles that I could carry in the railway trains; but when I did get a strong one I tested the gas at Plymouth—15 candle gas, and found that it gave

a very great light. I carried the same burner and mantle back to Manchester and tested it with 20 candle gas which was being supplied by the corporation in that city, and did not find much difference in the illuminating power. I said, "This is a fine thing, and we will adopt it as soon as we can, because with our poor gas in the South with the Newcastle coal, it is a fine thing for us to have ; a fine thing for the public and a fine thing for everybody—that with our poor gas we could give the people a much better and much cheaper light." Well, there are a whole lot of figures worked out on this incandescent effect, flat flame burners, and that sort of thing. I should like to have gone into that, but have no time. Mr. Glasgow compares a whole lot of these figures with the price charged for gas light by the Gas Light & Coke Company, at 75 cents per 1,000. He has not told you that Sir George Livesey is supplying gas lower than that, about 2s. 3d. per 1,000, or about 55 cents per 1,000.

As to the operation of the business under the sliding scale, I do not think we can go into that at this time. As to the naphthalene troubles—I never was very much bothered with naphthalene, and I do not think anybody else would be if they manufactured their gas properly, properly condensed it and washed it before it was sent out to the streets. If that was done I do not think you would have much trouble then.

I think I told you I tested these two widely different qualities of gas, one against the other, and I think I was the first to do that. Dr. McAdam, of Edinburgh, also tested the incandescent burner with 12 candle gas, shortly afterward, against the 28 candle gas of the Edinburgh Corporation, and of course he saw what a great advantage it was to the public, and it was recommended to the Edinburgh Corporation that they should reduce the illuminating power of their gas. Sir George Livesey said at his shareholders' meetings that since he supplied his 14 candle gas he has not sold much more gas ; only what they would naturally expect from the natural increase in consumption. Of course the assumption was, by some people, that if he sold a lower grade of gas the people would want very much more of it, and of course the insinuation was that it would be cheap and nasty. Well, he tells you that he

has not sold any more and he also tells you what he has done. Sir George Livesey is a good and noble man. He tries to study his customers. He said, "I will help them in every way to burn this gas properly," and therefore he gives them new burners, so that the people can get every advantage they possibly can out of the gas; and I have no doubt whatever that through the action which Sir George Livesey has taken that in his district to-day, with his 14 candle-power solid coal gas, he is giving better light among the consumers than they are getting from other companies, where they have not given them these modern and improved burners.

This is an important question—this question of getting in touch with the consumers. Their interest and yours are identical. Thirty years ago I lectured on this subject, and tested burners and pointed out that it was to the advantage of the consumers to use the best burners they could get, and the result was that in the course of time they used the best burners. I was ridiculed at the time by the public press and they said: "Can any good come out of Nazareth?" They said: "Here is a man coming forward who tells us that if the people would use his gas properly he would not sell so much of it and they would not need so much of it." That is what is taking place with this incandescent burner. But I am digressing, and will cut my remarks short. I would ask if Mr. Humphreys knows what the calorific value of the gas supplied by the South Metropolitan Gas Company was under their Act of Parliament when they were supplying 16 candle gas. I will tell you myself what it was. The calorific value was 645 British thermal units—that is higher than is given by Mr. Glasgow for the Gas Light & Coke Company's 16 candle mixture. There is no doubt whatever that to-day Sir George Livesey is supplying gas containing a calorific value of about 600 British thermal units. I have made that quality myself over and over again in Maidstone and other towns from the coal he is using.

Just one word: Why have we tried to reduce the standard? Why have we gone into this low-grade gas? Some of us worked under an old dispensation in years gone by. We obtained as much gas as possible out of the coal, and made a large volume of gas from Newcastle and Durham coal, of 14.5

candle, a large volume of good calorific value; but the wiseacres stepped in and said: "You must put the illuminating power up." We objected; but it was imposed upon us, and we had to use cannel. We did not like that, as it was too expensive at Maidstone, Plymouth and Stroud and other places. In some of these places we have been relieved of the obligation by convincing Parliament that they were wrong in imposing it upon us. We have got back again, and especially in Stroud I was the first to get the reduction after Mr. Livesey. Mr. Corbett Woodall assisted me in Parliament in maintaining the old candle-power for the Stroud Gas Company, simply because we did not want to go to the expense of getting cannel coal into the place or putting in carburetted water-gas apparatus, and thereby increasing the capital expenditure for the sake of one candle. At these places we sell gas cheap—at Maidstone about fifty cents a thousand, at Plymouth about half a dollar. What you gas engineers want to aim at is to go in for getting all the gas you can out of your coal; drive your gas off at high temperatures, and do as I have recently done in Germany, and you will get an increase of 1,000 cubic feet more per ton of coal carbonized. The higher the temperature the greater the permanency and calorific value obtained. The question is how many units of light you get out of a ton of coal with quick heats and working off good charges. That is the way I would advise you men to look at the question—work up your heats, get decent coal, and get it out in one distillation only if you can, and, if you cannot, get enrichment.

Mr. Walton Clark (Philadelphia, Pa.):—I am very sorry to have heard Mr. West suggest that Mr. Glasgow came from England to America to attack English gas men. I have had nothing to do with this controversy in England, but I have observed from the papers that Mr. Glasgow has made a vigorous fight in the stronghold of English gas men against this reduction in candle power. It does not appear to me that Mr. Glasgow has attacked anybody. I think he is attacking a certain idea or proposition in the manufacture of gas. I do not believe it can be treason, even in England, to call atten-

tion to discrepancies and disagreements in the statements of English gas men. I do not yield anything to Mr. West in admiration of Sir George Livesey, whom I regard as one of the greatest living gas men.

I desire to call the attention of Mr. West to his error in stating that Mr. Glasgow said that certain photometers are not suited for the work to which they were dedicated. All that Mr. West has said on that point, and his criticism of the argument of Mr. Glasgow, as far as it hinges on that point, falls to the ground, has no force in it, as the statement was made by Sir George Livesey and not by Mr. Glasgow. I also regret to hear Mr. West say that Mr. Glasgow insinuated that the South Metropolitan Company was not living up to its parliamentary requirements. I forget the exact page, but at any rate somewhere in this article Mr. Glasgow particularly states that they are living up to the parliamentary requirements. I find on page xxxvii Mr. Glasgow uses the following language: "No one denies that the Company have lived up to this limited sense of their obligations and that their works and official tests have satisfied the legal standard." So Mr. West will have to agree that Mr. Glasgow does not say or insinuate that the South Metropolitan Company have not lived up to the legal requirements.

I have given very little study to this paper; it is long and important, and I am not familiar enough with it to thoroughly discuss it. I only desired to call attention to one or two errors Mr. West had fallen into inadvertently, and with that I will close.

Mr. John West:—I have just noticed that the statement as to the portable photometer was not Mr. Glasgow's, but Sir George Livesey's.

Mr. Alex. C. Humphreys (New York):—As I said before reading Mr. Glasgow's paper, I am not able to do justice to the discussion of this paper as could Mr. Glasgow himself. But now let me add that I feel quite competent to meet the points which have been brought out in this discussion. I should like to point out to Mr. Doherty, first, that Mr. Glasgow is the last man in the world—and in saying that

I mean just what I say—to write a paper and come here with the idea of attacking anyone not present, or who was not in the position to defend himself. Mr. Glasgow is ready to meet any criticism that may be brought against his paper either here or elsewhere. Mr. Doherty's point is that it is not fair to here discuss English practice, because such discussion may involve an attack on English engineers not here to present their side. Let us stop to think a minute. Then we must confine our discussions to home practice, or first be sure before reading a paper that the foreign engineers interested in the practice under discussion are able to come over here to defend themselves against criticism. It is only necessary to so state the case to show how the work of our technical societies would be hampered and limited. Although I had not expected to speak of it, the personal nature of Mr. Doherty's and Mr. West's criticisms moves me to tell of an extra precaution taken by Mr. Glasgow before he left London. Mr. Glasgow greatly respects and admires Sir George Livesey, and, I believe, Sir George admires and respects Mr. Glasgow. Mr. Glasgow wrote to Sir George Livesey about this paper, and said that he would like him to read the manuscript and prepare a written discussion in answer to be presented at the same time with the paper. Mr. Glasgow guaranteed that the American Gas Light Association would be glad to receive the discussion and put it on its minutes alongside of his paper. Sir George Livesey in most courteous terms acknowledged Mr. Glasgow's evident desire for fair play, and said he did not care to take advantage of Mr. Glasgow's offer. That disposes of that part of the criticism.

I would point out right here that this discussion shows very plainly the difficulties Mr. Glasgow has had to contend with in discussing this question on the other side. Almost without exception, the men who have discussed the question with him in the papers have been in exactly the same position as that occupied by Mr. West to-day. Mr. West, I hope, will pardon me. He has been plain-spoken and I shall be. That is a habit I have. These gentlemen, just as Mr. West has done to-day, attempted to discuss a question which they did not fully understand. They did not even go fully into the study

of the letters which they have attempted to answer. I would advise Mr. West now not to be satisfied with simply reading this paper. Simply reading a paper of this character is not sufficient—any of us who attempt to discuss one of Mr. Glasgow's papers, and certainly such a paper as the one before us, without any more preparation than a single reading, will be likely to find ourselves in trouble. Mr. Glasgow's papers sometimes remind me of Rankine's engineering text-books. Rankine omits many intermediate steps because he considers them elementary and self-evident. Those of us not so gifted mentally have to work out and supply more or less of these intermediate steps to completely follow the demonstration. So it is sometimes with Mr. Glasgow's writings. To follow them they must be studied. That Mr. West has not studied this paper is shown by his discussion. In fact, a large part of Mr. West's argument is based upon an incorrect reading of the paper; namely, he places Sir George Livesey's words in Mr. Glasgow's mouth and then proceeds to combat the statement by reason of its mistake as to its authorship. Sir George Livesey would be the last man to avoid responsibility for this statement as to the special photometers.

Now, in regard to these tests. Mr. West says that Mr. Glasgow has come over here to try to deceive you in regard to the South Metropolitan gas. He has done nothing of the kind; he has not attacked the South Metropolitan gas. He has taken the conditions as they are acknowledged to exist in London and presented them to you. That is not an attack. In regard to the difference between the official tests and the special tests, Mr. Glasgow knows that the former are not made at the works, and he acknowledges that when the gas passes the tests at these official testing stations, the parliamentary requirements have been met. But these special tests were made to determine how the gas would stand up under greater exposure. These tests were made with the nominal 16 candle-power gas and the nominal 14 candle-power gas. Sir George Livesey says that while these were not complete tests, they were fair as *comparisons*. The unstable enrichment carried by the 16 candle-power did not reach the consumer. What appears at the bottom of page xxxvii of the paper is an

answer to Mr. West's charge that Mr. Glasgow is accusing the South Metropolitan Company of deceiving the public as to the quality of its gas supply. Sir George Livesey says he had never understood that they were to supply 16-candle gas to every consumer, but that it was to be 16 candle-power as sent out from the works, and that gas of 16 candle-power was to be found at the testing stations. Again, he says, "My opinion is that if Parliament had intended 16-candle gas to be given everywhere, it would have required us to supply 17 candles." Mr. Glasgow then goes on to say that no one denies that the tests of the company's gas have satisfied the legal standard. But again, read this part of the paper carefully for yourselves.

Mr. West has spoken disparagingly of Dr. Clowes. Dr. Clowes enjoys a high reputation in his particular line of work. An eminent scientist on the English Educational Commission now visiting this country has within a few days borne testimony to Dr. Clowes' special ability in this line.

As the hour is late I will not take the time to follow in detail Mr. Glasgow's calculations, to some of which Mr. West has referred. I urge Mr. West and you all to follow out Mr. Glasgow's calculations carefully and see if they are not correct. In this connection, it is well to refer to Mr. Glasgow's papers previously read before this Association. In these papers he shows you the conditions assumed and tells you to take these as general cases, and shows you how to apply this general case to your own separate local conditions. He gives you the opportunity to do your own figuring, and that does not sound unfair.

Mr. West questions Mr. Glasgow's comparison as to land required for coal gas and water gas works. Mr. West can see across the river from New York a water gas plant of a daily capacity of 30,000,000 cubic feet of gas on six acres and with 10,000,000 cubic feet storage capacity.

Mr. West makes the point that there are no coke piles now in England. That is just what Mr. Glasgow tells us. The advent of water-gas cleaned up the coke piles and changed the condition of the market. Ten years ago I went through many of the gas yards of Great Britain and I saw many large

piles of coke. In a number of cases, where then there were immense coke piles, the yard space is now occupied by the greatest coke consumer—that is, the water gas plant. Mr. West questions the accuracy of Mr. Glasgow's comparative table of labor costs as far as it covers the comparison between water gas and coal gas by machine stoking. If Mr. West's machines will show a lower cost for labor than Mr. Glasgow has shown, Mr. Glasgow is open to conviction. We know Mr. West does fine work with his machine stokers. But bear in mind, Mr. Glasgow's argument does not in the slightest degree depend upon the absolute accuracy of the comparisons shown in that table. Mr. Glasgow's proposition as to the economical advantage to be found in selling gas of the higher candle-power is based upon the costs of manufacturing as disclosed by published accounts of the London companies.

Now in regard to naphthalene. We are all willing to confess that here in the United States we *have* had a great deal of trouble from naphthalene. Many papers have been written on the subject and the subject has been discussed until it is threadbare. I would say to Mr. West that if he can show us how to avoid the deposition of naphthalene in the manufacture of a straight coal gas, we can make it worth his while to come over to educate us. Mr. Glasgow shows that an auxiliary water gas plant, properly operated, cures this naphthalene coal gas trouble. Apparently there is another direction in which we could learn from Mr. West. He says we should run our retorts with higher heats, and so get more gas *of a higher calorific* value. He says if we cannot do this, there are English engineers who can. There is a great future for Mr. West in this country if he will show us how, by the employment of higher carbonizing heats, to distill from a given quantity of coal not only an increased volume of gas, but to give to that increased volume a higher calorific power.

Something has been said about Mr. Glasgow's arguments having fallen to the ground. I think the boot is on the other leg. The arguments made by Mr. West all the way through are based on misconceptions—he did not even understand who was responsible for the statements contained in the paper; matter quoted he has confounded with direct statements by

Mr. Glasgow himself. The simple question asked by Mr. West, why Mr. Glasgow did not make the comparison between the enriched 16 candle-power gas and the South Metropolitan Company's 14 candle-power coal gas, is an admission that Mr. West does not understand why Mr. Glasgow made the investigation. Mr. Glasgow took the facts as found in recent London practice, verified the tests and comparisons, and on these facts made his argument. The South Metropolitan Company, acting under authority of Parliament, supplies its consumers with a gas of reduced candle-power at a reduced price. Then the proposition is made to force the Gas Light & Coke Company to reduce the candle-power of its supply, and in that connection make a certain reduction in its price to its consumers. Then Mr. Glasgow shows by the South Metropolitan results applied to the Gas Light & Coke Company case that if the reduction in candle-power and accompanying reduction in price were forced upon the Gas Light & Coke Company the result would be a loss to the company and to its consumers. Mr. Glasgow was engaged in this investigation for many months, and he here gives us the result of his work. He verified these quoted results by tests which he cites.

Why did he take 16 candle-power mixed gas and compare it with a 14 candle-power mixed gas instead of with a 14 candle-power coal gas? Because that was the proposition the Gas Light & Coke Company was required to face—a reduction of 2 candle-power. It was for the company to determine what would be the commercial result of such a reduction; and, as in case of reduction in candle-power, the water gas would still be used as an auxiliary, the comparison had to be made with a 14 candle-power mixed gas. The Gas Light & Coke Company, by reason of its experience, believes in the collateral advantages of water gas. Sir George Livesey and Mr. West apparently do not believe in these advantages, and they have the right to their opinions. Mr. Glasgow has more than opinions, he has the facts as a warrant for his opinions.

Mr. West speaks of not having seen the record of the Dessau and Bunte experiments. Mr. Glasgow has seen it, studied it, and as a result he shows that the conclusions drawn therefrom are worthless. As Mr. West acknowledges that he

has not even seen this record, it seems hardly worth while for him to express any opinion thereon. He cannot see how Mr. Glasgow can be correct in his condemnation of these experiments. I can quite understand that Mr. West may fail to see this point and still that the point may be there.

THE PRESIDENT :—Does Mr. West wish to make any further remarks ?

MR. WEST :—I do not know what the rules of debate are in America. I have had my say and Mr. Glasgow has had his say. I do not accept his conclusions. It would take me another hour to refute what he has said. He has not made any calculations of the thousand feet extra gas I get out of the coal, and he must take that into his calculation when he estimates the cost of the Gas Light & Coke Company's gas.

MR. HUMPHREYS :—It is not worth while to go into any calculations with Mr. West at the present time, in view of the fact that Mr. West admits that he has not studied Mr. Glasgow's figures. Mr. West says he will go home to Europe and study this paper carefully and probably prepare a reply. I can say if he will do so Mr. Glasgow and I will be delighted. I can promise him that his argument will receive careful attention and a careful reply if there is any necessity therefor.

MR. WEST :—I am satisfied of that. If Mr. Glasgow were here I should receive the greatest possible courtesy and attention from him. If he replies to the statements made by me, and any of them are erroneous, I will, if you will permit it, correct any of the statements I have made. If I have made any misstatements I will not only admit that I am in the wrong, but will apologize for it.

MR. JAMES SOMERVILLE (Indianapolis, Ind.) :—It is getting late ; but I am sorry that a paper like this, one of the finest papers ever presented before this Association, should lead to a discussion which takes the low plane of a sort of controversy. I think the subject of the paper is much higher. Mr. Glasgow has stated some great truths in his plain and clear-cut way ; and I want to propose that this Association

give him a cordial vote of thanks for the paper, and that we send our sympathy to him in his trouble.

He has pointed out (sometimes I wish this thing of candle power could be abolished altogether, it is a misnomer) that we are purveyors of energy, and that is the great point I notice in the paper. In reality we are all selling so many units of energy. We should not forget that, and when people get up with an argument, as has been done, and say that 500 heat units will do a certain amount of work, if burned in a certain burner, as well as 650 heat units will do it, I cannot follow such an argument at all. I move, as I said before, that a vote of thanks be tendered to Mr. Glasgow for preparing the paper, and also a vote of thanks to Mr. Humphreys for reading it.

A MEMBER:—I think a telegram of sympathy should be sent to Mr. Glasgow.

The motion was seconded and unanimously carried.

The meeting adjourned until Thursday morning at 10 o'clock.

SECOND DAY—FIRST SESSION.

The President called the meeting to order at 10:05 o'clock and called for the report of the Committee on the President's Address.

Mr. Walton Clark presented the following:

REPORT ON PRESIDENT'S ADDRESS.

American Gas Light Association:

Your Committee on the President's Address for the year 1903 has the honor to present the following report:

It is the understanding of your Committee that its duty is to comment frankly on the address, commending such opinions expressed by the President as are agreeable to the sense of the Committee, and criticising the attitude of the President if in anything he has expressed opinions that do not commend themselves to the judgment of the Committee.

The address gives evidence that your President has bestowed upon it such thought and care as are to be expected from a man who feels the responsibilities of the exalted position Mr. Miller now holds, and knows that his utterances will have weight with the men who have elected him thereto.

We recommend to your careful thought Mr. Miller's warning that your companies should have ample storage capacity, to enable them to meet such shortages in coal supply as bitter experience has taught us are to be, from time to time, expected.

The labor problem, which is always with us, and never permanently solved, has forced itself on the attention of some gas managers during the past few years in a way almost unprecedented in the gas industry. As Mr. Miller points out, it is the duty of every manager of a gas property to so arrange that there shall be no interruption in the supply of his commodity through disputes with his workmen. How he can best do this without discriminating against any competent man is a question for local solution. We believe that such fair treatment as your good sense and good hearts will prompt you to extend to each of your employees will in the future, as in the past, save you from the threat of serious trouble with those who are doing the manual work connected with the conduct of your industry, and neutralize the effect of the demagogues' efforts to persuade them to disturbance.

What your President says of carbonizing apparatus and machinery is of great interest. The dispute between the advocates of inclined retorts, and of horizontal retorts operated by machinery, is not, by any means, settled. It is to be hoped that someone competent to the task will present to the Association in 1904 an exhaustive paper upon this subject. Progress is being made every year, and it is the duty of the Council of the American Gas Light Association to insure that this progress is noted on the Minutes of our Annual Meetings.

Intimately connected with this question are the claims put forth by the advocates of the by-product coke oven. It is not, we believe, claimed by the coke oven people that the ovens are economically applicable to all situations ; but it is

claimed by them, with confidence, that there are situations in which it is to the advantage of gas companies to operate coke ovens for the production of gas and coke. Your Committee believes that a paper on this subject would be of great value.

Your Committee congratulates you and the industry in general that Mr. Miller has been able to record the fact that the gas business is at last keeping abreast of other manufacturing interests, in the attention which is being given to the use of labor saving machinery and to the design of apparatus, and that the old standards which for a generation were deemed good enough, have met the necessity of justifying themselves.

Mr. Miller presents a very encouraging statement of the percentage efficiencies of different sources of illumination, showing that gas has a very low percentage efficiency. With the knowledge that it nevertheless competes successfully with electric lamps of much higher efficiency, we may look with confidence to the future, and congratulate ourselves that on this point the margin for improvement in gas lighting is much broader than the margin for improvement in electric lighting.

Your Committee agrees with Mr. Miller that there is a sacrifice of light distribution in the cluster burners known as "gas arcs," but cannot agree with him that, therefore, the use of "gas arcs" should be discouraged. This is a matter in which there may reasonably be a difference of opinion. Your Committee hopes that this question may be thoroughly discussed at this meeting, and to that end has inserted a question in the Question Box asking for a statement of experience in the use of the "gas arcs." To the mind of the Committee, it does not follow that because the three or four Welsbach lights used in a "gas arc" do not distribute light as uniformly throughout the space illuminated as would the same number of Welsbach lights separated to a greater distance from each other, there are no advantages in the use of the "gas arc." Your Committee, as stated above, hopes to hear this matter thoroughly discussed.

Your Committee heartily endorses Mr. Miller's defense of gas of high heating efficiency. It would require very decided advantages in the cost of production to persuade the men in

charge of the gas industry that they should reduce the calorific value of the gas they supply.

The question of papers and discussions is again brought to the front by Mr. Miller's address. This Association may reasonably be arraigned by its friends for the indifference of its members to the preparation of papers and discussions thereon. The figures given by Mr. Miller, showing the percentage of speakers to attendance, are instructive and mortifying. Something should be done to improve the existing conditions. Under our form of government the Council is responsible for the management of the affairs of the Association, except when relieved by your refusal to endorse its recommendations. Its duty is to utilize the intelligence of the membership to the end that our meetings may be as instructive as our abilities make possible. We recommend that you approve Mr. Miller's suggestion that the duty of obtaining papers and discussions be delegated to the Council of the Association, it being left to the Council to determine whether or not it will work through a committee.

Your Committee would comment at length on the Gas Educational Class referred to by Mr. Miller, were it not that this matter has been fully covered in the paper presented by Mr. Alex. C. Humphreys and in the discussion that followed.

Your Committee fails to understand the indifference of the members of this Association in the matter of standard street main fittings, and regrets, with the President, that this indifference exists. It seems to us useless to advance any arguments in the matter. You all know of these standards. You have had them prepared, and if you don't use them it must be, as the President suggests, because the dime and ease of the moment appear to you of more importance than the dollar and comfort of the future. At least one large gas interest uses standard fittings and pipe, and believes it profits thereby. Your Committee believes you would all profit by a similar course.

With the fate of the standard fitting movement in mind, we fear it may be useless to urge you to the adoption of the system of accounts proposed and issued during the past year by your Committee on Uniform Accounts. Nevertheless, we

add the weight of our commendation to the President's strong endorsement of the system, and hope, with him, that its general adoption will be accomplished in the near future.

We congratulate you on the character and the quality of the Presidential Address upon which we have the honor to report.

This Report is unanimous, except that Mr. Morris dissents from the expressions relative to gas arcs.

WALTON CLARK, *Chairman.*
W. CULLEN MORRIS,
IRVIN BUTTERWORTH.

THE PRESIDENT :—Gentlemen, you have heard the Report of the Committee on the President's Address. What action will you take?

MR. J. H. KEPPELMAN (Reading, Pa.) :—I move that the report be received and filed.

MR. THOMAS LITTLEHALES (Syracuse, N. Y.) :—I would like to ask a question. From reading the Report of the Committee do I understand correctly that it is the intention to limit the papers to such as may be selected by the Council? I would like to have that question made clear. If so, I think it would be a mistake—an utter mistake.

MR. CLARK :—The proposition on this subject is that the Council take charge of the matter of procuring papers to be read at the meeting instead of leaving it to the Secretary. The Council to-day passes on every paper read at the meeting. No paper is read before the Council has passed on it. The proposition now is to take this matter of getting papers out of the Secretary's hands and let the Council look after it; the idea being you will get the influence then of a dozen men who are on the Council. We hope by having the efforts of a dozen men directed to this question to get more papers than we now have.

MR. LITTLEHALES :—Do I understand, Mr. President, that it is the intention to limit the papers to such as may be offered by gentlemen invited by the Council, or do the mem-

bers still retain their right and privilege to submit the papers? I would like to have this matter clearly understood before the motion is put.

THE PRESIDENT :—I do not think there is any intention of limiting the papers. The idea is to endeavor to get good papers, and we think by having a larger force at work on the matter we will meet with greater success. Most assuredly the Council will be glad, indeed, to welcome any suggestion of any member who has anything he feels is worthy of being presented to the Association. I wish that was more thoroughly understood. Those who have had to do with the getting of papers appreciate how welcome is a suggestion from anyone who has one to make in regard to the subject of the presentation of papers at our meetings.

MR. KEPPELMAN :—I think the motion should be changed, and I should like to have the privilege of changing it—that the Report be received and the recommendations of the Committee be adopted.

(Carried.)

THE PRESIDENT :—The next order of business will be the Report of the Committee on the Place of Next Meeting. Mr. C. J. R. Humphreys is the chairman of the committee.

MR. C. J. R. HUMPHREYS (New York City) :—Mr. President and Gentlemen : Your Committee appointed to recommend a place for the next annual meeting of the Association would report as follows : The present meeting being held in the West, the Association would in the natural course of events hold its next Convention in the East ; the Committee, therefore, had in mind to recommend the city of Washington, but noting that some of the members of the Association are desirous of having the 1904 meeting held in St. Louis on account of the Exposition to be held there next year, the Committee has decided to recommend that the meeting be held at Washington or St. Louis, and will ask the Convention to make choice between the two cities.

On the one hand, the Exposition which will be held at St. Louis is planned on such large lines that it is sure to be of

interest to all, and the Association has invitations from the Mayor of the city, the President of the Exposition and others to hold the 1904 Convention in St. Louis. On the other hand, it must be difficult to provide proper hotel accommodations for the members at reasonable rates in St. Louis next Fall, whereas in Washington the hotel accommodations are always ample and the rates are reasonable at the time of year when our meeting is held. Washington is always a popular place for holding our meetings, and it is fair to assume that the work of the Convention will pass off better away from the attractions of the Exposition. With these points in mind, the Committee will ask the Association to make choice between the two cities.

C. J. R. HUMPHREYS, *Chairman.*
WALTON CLARK,
E. G. COWDERY.

THE PRESIDENT :—Gentlemen, you have heard the Report. What is your pleasure?

MR. J. H. KEPPELMAN (Reading, Pa.) :—I move that the meeting be held in the City of Washington.

The motion was seconded.

THE PRESIDENT :—Is there any discussion? If not, the Chair will put the question.

MR. DANIEL R. RUSSELL (St. Louis, Mo.) :—Being from St. Louis, I am anxious for the Association to go to that city. I understand there will be five or six hotels of different sizes, which will accommodate the members of the Association about the grounds of the Exposition. There is to be one large hotel inside of the grounds, two large ones adjoining and a number of smaller ones. These hotels will be well fitted up and will be well run. If the Association members either in a body or separately will write in sufficient time, they can secure good accommodations at reasonable rates. I think if the Association should have its meetings on the Exposition grounds they would be well attended, and I cannot see any reason why the discussion of papers presented should not be just as full and complete as if the Association met in the city of Washing-

ton. Washington is a place which also has many attractions. I remember on the occasion of our last meeting in that city that a great deal of time was taken up in visiting places of interest. I think, furthermore, that as this Association is a National Association, not a Western Association, nor an Eastern Association, nor a New England Association, we should do everything we can to make it national in scope, and we should hold more of our meetings further West. If my memory is correct, in thirteen years the meetings have all been east of the westerly line of Buffalo or Pittsburg, excepting four meetings which have been held in the West, and I think it would be for the good of the Association if the West had more meetings; we would get a greater number of members from the West, and make the Association more truly national in its character.

I prefaced my remarks by saying I felt strongly in favor of St. Louis, being a St. Louis man, and I hope the Association will decide to go to St. Louis, where they will certainly have a most hearty welcome.

Mr. Henry L. Doherty (New York City):—I am a Western man, no matter where I register from, but I do not believe a good convention could be held at St. Louis in connection with the World's Fair. I have attended a great many conventions, some of which have been held at places where there was an Exposition, and unless there is some unusually strong reason for going to St. Louis, I would not advise you to go there. It is hard to keep the members together and have a good meeting, hard to have an interesting meeting. I do not know whether the Association has ever held a meeting in Washington, but I think they will find that an excellent convention city, and a city containing many points of interest which will not be of a character to keep the members from attending the sessions of the Convention, and I am in favor of going to Washington.

Mr. Thomas D. Miller (New Orleans, La.):—I understand that the American Gas Light Association is a democratic body to be ruled by the majority. I believe there is no question in the mind of anyone who has given the thing careful

thought, but that the general feeling is that the meeting next year should be held in St. Louis. Washington we will have with us always; the St. Louis Exposition will be only next year. I think that if even all that is said against St. Louis is true, that there never has been a successful convention or association meeting held at a time like that, it is not logical to say that it cannot be done. We certainly do learn by experience, and if our experience in the past in holding these meetings at a time like that has indicated that they are failures, let us profit by our experience and hold a meeting at such a time that is a success. I have not heard anything about the Gas Congress at Paris being a failure because it was held at the time of the Exposition. I have not heard anybody offer any good reason why our meeting should not be held in St. Louis. I am from Missouri, and no one has shown any arguments to me why we should not go to St. Louis next year.

Mr. Alfred E. Forstall (Montclair, N. J.):—It seems to me the question is whether you want a meeting of the Association for the purpose of meeting and discussing subjects of interest to the members, or whether you want a meeting of the Association for the purpose of seeing the Exposition. I suppose it would be easier for me if the meeting were to be held in St. Louis, as there would be less work for the Secretary to do; but if we are to meet for the benefit of the members of the Association, from the technical standpoint and not from the pleasure standpoint, St. Louis will not fill the bill. The experience of the Association at Chicago will certainly bear that out.

Mr. Thomas Littlehales (Syracuse, N. Y.):—As many of the members are absent this morning, would it not be well to take the ballot of those members by circular, so as to see what the preponderance of opinion is throughout the entire membership of the Association as well as those present at this meeting. Probably there are not more than half the members here this morning, and I would suggest that the matter should be left open in such a way that it can be decided by the Council on receipt of replies to a circular which might be sent to each

member. I make the suggestion for the consideration of the members.

Mr. Walton Clark (Philadelphia, Pa.):—A motion has been made and seconded and I call for the question.

Mr. Edward G. Cowdery (St. Louis, Mo.) :—I am not anxious to influence the general opinion of the members in favor of going to St. Louis, but I think it is only fair to bring out some of the points that are not fully understood. The Exposition to be held in St. Louis will not only be the largest, but it will be the finest Exposition that has ever been held. I think there is no question about that. The whole object of the Exposition management has been to make it such. They are not only to make an Exposition of appliances and things in general, which have usually been brought out in Expositions, but they intend to give this Exposition a much wider scope, to cover the ground completely; and one of the features of this exhibition has been to attract conventions to St. Louis at the time of the Exposition—to make it a great point to have conventions go there at that time, with the object of holding the conventions on the Fair Grounds. With this end in view, the officers of the Exposition have prepared, and are preparing, a list of scientific subjects upon which they intend to have papers prepared and presented through lectures, and read at different times during the Exposition period ; and the intention is to select one hundred of the brightest men in the world in their particular lines to prepare papers upon the various subjects of interest. The appropriation for this subject is some $200,000, so that you can see that the intention is to bring out the best in connection with all scientific subjects. There would probably be no trouble in getting at least one of these papers presented at the time of holding any convention, and no doubt we could have a paper presented relating to our business at our Convention if we should meet in St. Louis. I think this is a very strong point of interest to the Association in every way, and I felt it was only right to bring it out.

The President :—Gentlemen, you have heard the question—the question is on the motion to hold the next meeting in Washington, D. C. All in favor say aye. (Members

respond.) Those opposed will say nay. (Members respond.) The Chair is in doubt as to the vote. Those in favor of going to Washington will please stand up. The associate members, under the Constitution, do not vote. Mr. Butterworth and Mr. Douglas will kindly count the members standing on their respective sides of the room. (Members in favor stood up.) Those opposed will please stand up. (Members opposed stood up.) Gentlemen, the motion is carried in favor of Washington by a vote of 57 in favor of going to Washington to 41 opposed to Washington.

The next order of business will be the lecture which Mr. White has been kind enough to prepare on the subject of Gas Engines. I hope you will listen to this with a great deal of attention, as it is a subject which interests us all very deeply and will be of immense value at the present time and for our records. I have great pleasure in presenting Mr. White.

Mr. White delivered the lecture as follows:

DIFFERENT GASES IN GAS ENGINES.

ALFRED H. WHITE.

The art of making large gas engines has made enormous strides in the last few years. Engines of 500 horse power are no longer considered large, and engines of 1,500 horse power are being built. But we hear very little of large gas engines built for illuminating gas. Almost all of them are built for fuel gas, and many of them for blast-furnace gas. The discovery that blast-furnace gas could be profitably used in gas engines has raised quite a furor in the engineering press, because of the vast possibilities of waste power that may thus be made useful. It is certainly startling to hear that one of our large 500 ton blast furnaces can, after using all the gas it needs for all its own uses, develop and sell nearly 15,000 horse power. On this basis, if all of the blast furnaces of the United States were equipped with gas engine plants, there would be one and a half million horse power generated over and above the needs of the furnaces for all purposes.

Blast-furnace gas is so poor that it will scarcely burn in the open air, and ten years ago the proposal to use it in gas engines was received with scorn. But to-day we find that out of one hundred heat units supplied to the engine, as many, and often more, are transformed into useful work in the case of engines fed with blast-furnace gas than with engines using lighting gas, and one of the builders of large gas engines has stated as his ideal gas for gas engine use one which is to all intents and purposes the once-despised blast-furnace gas.

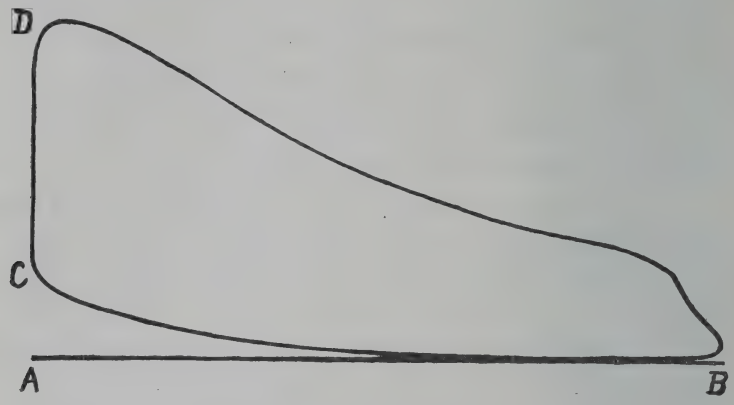
The earlier gas engines were all built for illuminating gas, and the adoption of the lower grade power gases has been a growth of recent years. What is it that has caused such a change of sentiment among some, at least, of the gas engine builders?

It is to this phase of the subject—the influence of the kind of gas used—that I propose to devote the time allotted to me this morning. Its consideration involves some study of the phenomena which take place in the engine cylinder.

The cylinder is the most important part of the engine, because there the power is developed and there the most serious sources of loss reside. The operation is apparently simple. A combustible gas is mixed with air in proper proportion and ignited. The gas rapidly burns—explodes—to carbon dioxide and water, and the heat set free expands the gases which do work on the piston. But the first step in remedying a fault is to find out where and exactly how great it is, and when we try to analyze the various sources of gain or loss in the cylinder we find ourselves possessed of very little certain information as to what goes on there, beyond the fact that a mixture of gas and air is drawn in, that combination takes place, and that later the products of combustion are ejected after doing a certain amount of work.

It was the advent of the Otto engine in 1876 which brought the gas engine into the realm of commercial practicability. The feature of value in this engine was the compression of the air and gas charge previous to its explosion. To effect this Otto boldly cut loose from all traditions (which were to give the piston an impulse every time it went forward) and gave the piston an impulse only on every other forward stroke, or

one impulse for every four strokes. An examination of this sketch of an indicator card from an Otto engine will serve to recall the cycle.



The piston moving from A to B draws in a charge of gas and air, compressing it at the return stroke to pressure shown at C. When the piston is on its dead point the charge is exploded, and the rise of pressure is almost instantaneous to D. The piston then moves forward under the influence of the compressed gases, the pressure falling off as the piston moves, until near the end of its travel the exhaust valve opens and the products of combustion are pushed out by the return stroke of the piston. The efficiency in an engine of this type, as deduced theoretically, may be shown to depend almost entirely upon the amount of compression to which the gases are subjected before explosion.

The higher the compression temperature the more efficient the engine. Practice has shown results according fairly well with the theory in this respect, and the natural result has been that manufacturers have kept increasing the compression temperatures until they have been forced to call a halt because of limitations set upon them by the nature of the gas used.

When a gas is compressed, say to one-fifth of its volume in as small a fraction of a second, the energy required to effect its compression is almost entirely converted into heat, which raises the temperature of the gas. The greater and more

rapid the compression, the hotter does the gas become, and it is easy in practice to heat a charge of gas and air so much that it will prematurely explode in the cylinder. The danger of this is greater in large engines than in small, because of the relatively smaller cooling effect of the walls in a large engine. The strains due to premature explosion are also more serious in large engines. Of all the gases, hydrogen is the one which most easily explodes under these conditions, and hydrogen is an important constituent of most of our commercial gases.

This danger of premature explosion puts an effective bar on too great increase of compression before explosion. It is because of the possibility of safely compressing blast-furnace gas more than other gases that this gas has become such a favorite with some engineers. Blast-furnace gas will carry about thirty per cent. carbon monoxide, three per cent. hydrogen, and the remainder carbon dioxide and nitrogen. This gas, mixed with a favorable proportion of air, will hardly burn, much less explode, with the promptness and certainty necessary in a high-speed gas engine. It is necessary to heat it by compression to make it explode, and compression may be safely carried much further with it than with the gas containing much hydrogen. For equal amounts of compression blast-furnace gas will show a much lower efficiency than a rich gas, but with greater compression an efficiency almost equal to and sometimes better than its old-time superior. Let us see if we can find any explanation for this.

It will be of interest to compare the theoretical flame temperatures and the volumes of the products of combustion at the elevated temperatures. I do not wish to take your time with the details of the somewhat wearisome calculations necessary for this, but have prepared them for printing in your Proceedings as an Appendix to this lecture. Let us take for comparison the carburetted water gas, blue water gas and blast-furnace gas, details of which are given in the Appendix, and determine what pressures would be exerted by the explosion of each with the theoretical amount of air. It will be convenient to assume an engine with a cylinder containing a charge of one cubic foot. The piston is not supposed to move

during explosion, which takes place at constant volume. We may calculate the theoretical temperature of combustion, and from that the theoretical pressure that would be produced.

The theoretical temperatures may readily be calculated if we know the composition of the fuel, the amount of air used, and the specific heats of the products of combustion. It is in connection with these specific heats that the greatest uncertainty arises. The specific heats of the products of combustion as obtained by Regnault from his experiments at ordinary temperatures gave preposterously high temperatures as theoretically possible. In 1883 Mallard and Le Chatelier by their classic researches on the explosion of gases in closed vessels obtained experimental data on the specific heats of these combustion gases at higher temperatures, and showed conclusively that the specific heats rise rapidly with increase in temperature. The principle of this work has been confirmed by others, although there is considerable divergence in the numerical results obtained by different experimenters. In the absence of any authoritative revision of their work, however, the Le Chatelier specific heats are probably those most frequently used by engineers. Unfortunately, the knowledge of them has remained almost exclusively in the hands of those accustomed to using the metric units and to reading French and German. Tables of these specific heats which I have calculated from the original data are given in the Appendix to this paper. In the calculation of theoretical specific heats we assume that combustion is complete and instantaneous, that there is no dissociation of the products of combustion, and that all of the heat produced is used in raising the temperature of the gases remaining after combustion. For this calculation we must know the amount of heat developed by the combustion of a given quantity of gas, and the amount and specific heat of each constituent in the products of combustion. It is customary to deal with volumes and not with weights of gases, and on that account it is much more convenient to use specific heats by *volume* and not by *weight*. The use of these volumetric specific heats also obviates largely the need of laborious calculations from the metric to the English units. The method of calculation is given in full in the Appendix.

From the temperatures thus obtained, and a knowledge of the amount of air required for complete combustion, it is possible to calculate the pressures that would be developed by the three gases under like conditions. When combustion of these gases takes place there is always a diminution in volume due to chemical combination. This may most conveniently be allowed for by assuming that the heat acts upon the gases of combustion at the volume which they would have when cooled. As this volume is less than one cubic foot, and the gases still fill the one cubic foot cylinder, it follows that they are under reduced pressure. What this is may be calculated from the ratio of the volumes under constant pressure of the gases before and after explosion. In the carburetted water gas, for example, the relative volumes are 6.90 before explosion and 6.68 after, from which it follows that the combustion gases in the cubic foot cylinder are under a pressure of $\frac{6.68}{6.90} = .967$ atmospheres. This is given in the table as "Initial Pressure Products of Combustion." The formula for explosion pressure is $\frac{p}{p_1} = \frac{t}{t_1}$: where p = initial pressure, p_1 = explosion pressure, t = initial temperature absolute, and t_1 = explosion temperature absolute. In the case of the carburetted water gas previously referred to $\frac{.967}{p_1} = \frac{290}{2463}$. The explosion pressure p_1 is then 8.02 atmospheres.

We may now tabulate the data for the three gases, leaving further details of calculations to the Appendix.

COMPARISON OF GASES.

	Carb. Water Gas.	Blue Water Gas.	Blast Furnace Gas.
Net heating value B. T. U. per cu. ft.	673.	278.	111.
Volume air required for 1 cu. ft. Gas	5.90	2.21	.792
Volume products of comb. from 1 cu. ft. Gas	6.68	2.75	1.627

Volume of charge in cu. ft.			
Gas	.145	.311	.558
Air	.855	.689	.442
Temp. of explosion at constant pressure,			
Degrees centigrade	2190	2145	1690
Absolute temperature	2460	2418	1963
Initial pressure products of comb. in atmospheres	.965	.855	.908
Pressure of explosion in atmospheres	8.02	7.13	6.15
Relative volume of gas in charge, carb. water gas being 1	1	2.01	3.85

The pressure generated by the blast furnace gas is considerably the lowest. But remembering the advantages to be gained by compression, it will be worth while to consider the results given by this gas if the charge is compressed before explosion to, for example, ten atmospheres. The formula for the temperature of adiabatic compression is

$$t_c = t\left(\frac{p_c}{p}\right)^{\frac{y-1}{y}}$$

which in this case is

$$t_c = 290\left(\frac{10}{1}\right)^{.29} = 565^\circ \text{ absolute} = 292^\circ\text{C}.$$

The temperature of explosion will be raised to practically this extent, or from 1963° to 2255° absolute. Using the same formula as before for the calculation of the pressure caused by this rise in temperature, we find $\frac{.908}{p_1} = \frac{290}{2255^\circ}$. From this $p_1 = 7.06$ atmospheres, as the increase of pressure caused by the explosion.

We may now summarize the results of these comparisons as follows:

	B. T. U. per cu. ft. Gas.	Relative B. T. U. per cu. ft. Charge.	Explosion Pressure Atm.
1. volume carb. water gas without compression	673.	673.	8.02
2.0 volumes blue water gas without compression	278.	556.	7.13
3.85 volumes blast furnace gas without compression	111.	429.	6.15
3.85 volumes blast furnace gas with compression to 10 atm.	111.	429.	7.06

The compression has caused an increase of over an atmosphere in the pressure to be attributed to the explosion. This has been gained apparently at the expense of the energy required to compress the gas, but in reality there has been no loss, because in the expansion the gas will theoretically return all the energy required to compress it. The gain has come purely from the greater temperature range and consequent greater pressure range through which the gas works. It starts the cycle under the pressure of compression plus the pressure of explosion, which is nearly an atmosphere greater than the pressure of the same gas exploded without previous compression, and it ends the cycle at the same pressure in both cases. The energy required to compress the gas on the in-stroke is theoretically all returned on the out-stroke. The higher pressure caused by the increased combustion temperature is pure gain.

The figures indicate that when the charge is previously compressed to ten atmospheres, four volumes of blast-furnace gas are practically equal to two of blue water gas without compression, and that under like conditions, two of blue gas are almost as good as one of rich carburetted gas. This gives some explanation of the rapid development of the blast furnace gas engine, which can work with higher compressions than engines burning hydrocarbon fuel. Does it also mean that the richer gases must always be at a disadvantage in this regard? Not necessarily.

Attention has of recent years been drawn again to a type of engine well known but never successfully introduced into

practice. Interest in this type has been aroused by the success of the Diesel petroleum motor. In this engine the piston on its return stroke compresses air only to a high pressure and a temperature hot enough to ignite any combustible. Just as the piston is at the dead point petroleum is injected into the cylinder, and ignited instantly on coming in contact with the hot air. Although this has been worked out on the large scale only for a petroleum motor, there seems no reason why the principle should not be successfully applied to gas. The gas may be compressed by a separate pump to a pressure sufficient to enable it to be forced rapidly into the cylinder at the proper moment. There can be no question here of premature explosion, and the only limiting condition would seem to be the mechanical one of making an engine to stand the strain.

The formula for calculating the theoretical efficiency of an engine of this type is not so simple as with the Otto engine. Efficiency will increase with the compression, but there will be involved the temperatures of compression, combustion and exhaust. It is almost useless to try to calculate the behavior of the engine if we also have to derive from rather uncertain theoretical data all three of these necessary temperatures. They are factors which it is extremely difficult to measure. The charge is compressed, exploded and exhausted in a fraction of a second, and it is almost impossible to obtain measuring instruments to register such rapid changes. Whenever we try to forecast the results of changes in a gas engine, or even interpret the results of experiments on our present engines, we are brought face to face with the painful inadequacy of our information on the subject of combustion in general and the operations in the gas engine cylinder in particular. The first step towards improvement is the determination and location of the present sources of loss.

We can determine the loss of heat to the jacket water, apparently inevitable and relatively constant. We can determine the loss due to the high temperature of the exhaust gases and to imperfect combustion—the latter, as Professor Meyer's researches have showed, being small with engines at full load running on lighting gas, considerably larger at half load, and

rising to important proportions in engines using low grade gas. But we can only explain fully the results obtained when we are enabled to follow accurately every step of the process of conversion of chemical energy into power. The cylinder of the gas engine is still largely a sealed book. We do not know how rapidly explosion takes place nor how high temperatures are obtained. The very data on which the calculations just presented to you have been based are somewhat uncertain.

The metallurgist can produce almost any kind of steel demanded from any materials furnished, and do it with certainty of success. The electrical engineer will tell to a nicety just how a dynamo will behave before the design is off the drawing board, for the scientific investigations of many men have disclosed the important factors which will influence the result. The design of a gas engine is almost entirely a matter of practical experience. Like its governing, it is of the "hit or miss" order. Progress has been made in spite of the drawbacks, but nothing like the advance which would follow a scientific knowledge of the underlying phenomena.

The Institution of Mechanical Engineers of Great Britain deserves great credit for its support of research work on this subject for the past five years. Valuable results have been obtained, but the subject is too large and complex to be solved by any one set of investigators. It must be worked out bit by bit by many workers, with the expenditure of much time and money, but the results will be well worth the effort and will redound to the honor of all who have furthered the work.

APPENDIX.

The Calculation of Theoretical Combustion Temperatures, by Alfred H. White.

The tables given below have been calculated from the original data of Le Chatelier, to which references are given, and the method of calculation is indicated in every case. Specific heats by weight and by volume both at constant volume and constant pressure are given for carbon dioxide, water vapor, nitrogen and oxygen for each 100° Centigrade

between 100° and 2500°. The inaccuracies of the experimental data on which the tables are based render it useless to attempt to interpolate in the tables more closely than to fifty degrees.

Calculation of Specific Heats According to Data of Le Chatelier.

ORIGINAL REFERENCES.

"If we represent by C_p and C_v the *molecular* specific heats, we have for all gases $C_p = C_v + 1.964$." (Mallard and Le Chatelier, Annales des Mines, 1883 [2], [512]).

The *mean molecular* specific heat at *constant volume* equals

$CO_2 = 6.50 + .00387$ t.

H_2O vapor $= 5.78 + .00286$ t.

Permanent gases $= 4.76 + .00122$ t.

The specific heats of gases are independent of pressure, even at pressures of six to seven thousand atmospheres, and the specific heats of permanent gases are equal to one another, even at high pressures and temperatures. (Le Chatelier, Seanc. de Soc. de Phys., 1888, p. 308-327, from an abstract in Wiedeman's Annalen der Physik, Beiblatter, 1890, Vol. 14, p. 364.)

For the calculation of temperatures of freely burning flames the specific heats at constant pressure must be used, which are obtained by adding 1.964 to the molecular specific heats at constant volume.

$CO_2 = 8.464 + .00387$ t.

H_2O vapor $= 7.744 + .00286$ t.

Permanent gases $= 6.724 + .00122$ t.

To obtain from these mean molecular specific heats the specific heats for 1 gram, we must divide by the molecular weights of the gases in question, for CO_2 by 44, for H_2O by 18, for N_2 by 28, O_2 by 32, etc. We thus get

Mean specific heats for 1 gram of gas.

	At Constant Pressure.	At Constant Volume.
CO_2	$= .1923 + .000088$ t.	$.1477 + .000088$ t.
H_2O vapor	$= .430 + .000159$ t.	$.3211 + .000159$ t.
N_2	$= .2401 + .0000435$ t.	$.1700 + .0000435$ t.
O_2	$= .2101 + .0000381$ t.	$.1487 + .0000381$ t.

As it is usually much more convenient to use the specific heats by volume, these may be calculated by multiplying these figures by the weight of a litre of the gas under standard conditions.

1 litre carbon dioxide = 1.965 grams.
1 litre water vapor = .804 grams.
1 litre nitrogen = 1.254 grams.
1 litre oxygen = 1.429 grams.

Mean specific heats for 1 litre of gas.

	At Constant Pressure.	At Constant Volume.
CO_2	= .3779 + .0001729 t.	.2902 + .0001729 t.
H_2O vapor	= .3457 + .0001277 t.	.2581 + .0001277 t.
Nitrogen, Oxygen	= .3010 + .0000545 t.	.2132 + .0000545 t.

TABLE I.

Table of Mean Specific Heats at Constant Volume.

Expressed in calories per litre.

Degrees Centigrade.	Carbon Dioxide.	Water Vapor.	Nitrogen and Oxygen.
100	.307	.271	.219
200	.325	.284	.224
300	.342	.296	.229
400	.359	.309	.235
500	.377	.322	.240
600	.394	.335	.246
700	.411	.348	.251
800	.429	.360	.257
900	.446	.373	.262
1000	.463	.386	.268
1100	.480	.399	.273
1200	.498	.411	.279
1300	.515	.424	.284
1400	.532	.437	.289
1500	.549	.450	.295
1600	.567	.463	.300
1700	.584	.475	.306
1800	.601	.488	.311
1900	.619	.501	.317
2000	.636	.514	.322
2100	.653	.526	.328
2200	.671	.539	.333
2300	.688	.552	.338
2400	.705	.565	.344
2500	.722	.578	.349
Difference for each 100°	.0173	.0128	.0054

TABLE II.

Table of Mean Specific Heats at Constant Volume.

Expressed in calories per gram.

Degrees Centigrade.	Carbon Dioxide.	Water Vapor.	Nitrogen.	Oxygen.
100	.156	.337	.174	.152
200	.165	.353	.179	.156
300	.174	.369	.183	.160
400	.183	.385	.187	.164
500	.192	.401	.192	.168
600	.200	.416	.196	.171
700	.209	.432	.200	.175
800	.218	.448	.205	.179
900	.227	.464	.209	.183
1000	.236	.480	.213	.187
1100	.244	.496	.218	.190
1200	.253	.512	.222	.194
1300	.262	.528	.226	.198
1400	.271	.544	.231	.202
1500	.280	.560	.235	.206
1600	.288	.575	.239	.209
1700	.297	.591	.244	.213
1800	.306	.607	.248	.217
1900	.315	.623	.253	.221
2000	.324	.639	.257	.225
2100	.332	.655	.261	.229
2200	.341	.671	.266	.232
2300	.350	.687	.270	.236
2400	.359	.703	.274	.240
2500	.368	.719	.279	.244
Difference for each 100°	.0088	.0159	.0043	.0038

TABLE III.

Table of Mean Specific Heats at Constant Pressure.

Expressed in calories per litre.

Degrees Centigrade.	Carbon Dioxide.	Water Vapor.	Nitrogen and Oxygen.
100	.395	.358	.306
200	.412	.371	.312
300	.430	.384	.317
400	.447	.397	.323
500	.464	.410	.328
600	.482	.422	.334
700	.499	.435	.339
800	.516	.448	.345
900	.534	.461	.350
1000	.551	.474	.356
1100	.568	.486	.361
1200	.585	.499	.366
1300	.603	.512	.372
1400	.620	.525	.377
1500	.637	.537	.383
1600	.655	.550	.388
1700	.672	.563	.394
1800	.689	.575	.399
1900	.706	.588	.404
2000	.724	.601	.410
2100	.741	.614	.415
2200	.758	.627	.421
2300	.776	.639	.426
2400	.793	.652	.432
2500	.810	.665	.437
Difference for each 100° . . .	.0173	.0128	.0054

TABLE IV.

TABLE OF MEAN SPECIFIC HEATS AT CONSTANT PRESSURE.

Expressed in calories per gram.

Degrees Centigrade.	Carbon Dioxide.	Water Vapor.	Nitrogen.	Oxygen.
100	.201	.446	.244	.214
200	.210	.462	.249	.218
300	.219	.478	.253	.222
400	.227	.494	.257	.225
500	.236	.510	.262	.229
600	.245	.526	.266	.233
700	.254	.541	.270	.237
800	.263	.557	.275	.241
900	.271	.573	.279	.244
1000	.280	.589	.284	.248
1100	.289	.605	.288	.252
1200	.298	.621	.292	.256
1300	.307	.637	.297	.260
1400	.315	.652	.301	.264
1500	.324	.668	.305	.267
1600	.333	.684	.310	.271
1700	.342	.700	.314	.275
1800	.351	.716	.318	.279
1900	.360	.732	.323	.282
2000	.368	.748	.327	.286
2100	.377	.764	.331	.290
2200	.385	.780	.336	.294
2300	.394	.796	.340	.298
2400	.403	.812	.344	.301
2500	.412	.828	.349	.305
Difference for each 100° . . .	.0088	.0159	.0043	.0038

TABLE V.

Relative volumes of certain gases, and their products of combustion in theoretical amount of air.

Air contains 20.9 per cent. by volume of oxygen and 79.1 per cent. by volume of nitrogen, the ratio of nitrogen to oxygen being 3.784.

Name of Gas.	Volume of O Theoretically Necessary.	Volume of Carbon Dioxide.	Products of Combustion.	
			Water Vapor.	Nitrogen.
Hydrogen H_2	0.5	0	1	1.89
Carbon Monoxide CO	0.5	1	0	1.89
Methane CH_4	2.0	1	2	7.56
Pentane C_5H_{12}	8.0	5	6	30.24
Hexane C_6H_{14}	9.5	6	7	35.91
Heptane C_7H_{16}	11.0	7	8	41.58
Ethylene C_2H_4	3.0	2	2	11.34
Propylene C_3H_6	4.5	3	3	17.01

As an instance of the method of calculating these temperatures we may take so-called "blue" water gas, made by blowing steam through white-hot coke, which will normally contain carbon dioxide, oxygen, carbon monoxide, hydrogen and nitrogen. Knowing the composition of the gas we may calculate from Table V the volumes of the products of combustion in the theoretical amount of air. We may also calculate from the analysis, or experimentally determine the heating value of the gas. In the case of a simple gas, like that under discussion, the two methods of determining heating value will check closely, but in the case of complex gases carrying unsaturated hydrocarbons, the experimental method is much to be preferred. In reporting the heating value of a gas, care should always be taken to distinguish between the "gross" and "net" value; the former being the result obtained in the calorimeter where the water formed in combustion is condensed in the instrument to liquid water, and the latter being a lower value calculated from the first where the water formed in combustion is assumed to escape as steam at the boiling point of water. It is evident that this "net"

value represents most nearly actual conditions, and is always to be used.

Table VI gives in detail the method of calculation for an actual sample of unpurified blue water gas, combustion taking place at constant pressure, that is, as if it were burned in the open air or in a furnace.

TABLE VI.

Calculation of theoretical temperature of combustion of blue water gas, with theoretical amount of air, no allowance being made for dissociation of products of combustion.

Percentage Comp. of Gas.	Volume in Litres.	Vol. O_2 Required for Combustion.	Volume of Products of Combustion.		
			Water Vapor.	Carbon Dioxide.	Nitrogen Accompanying the Necessary Oxygen.
O_2 4.4	.044	0	0	.044	0
O_2 0.3	.003	0	—	—	—
CO 41.0	.410	.205	0	.410	.775
H_2 52.3	.523	.261	.523	0	.988
N_2 2.0	.020	0	0	0	.020
100.0	1.000	.466	.523	.454	1.783
	Deduct	.003	Deduct for .003 Oxygen		.011
		.463			1.772

Net heating value of gas 278 B. T. U. per cubic foot, or 2474 small calories per litre.

Using specific heats by volume at constant pressure.

$.523 \times$ sp. ht. H_2O at 1850° (=.581) = .304
$.454 \times$ sp. ht. CO_2 at 1850° (=.698) = .317
$1.772 \times$ sp. ht. N_2 at 1850° (=.402) = .713
1.334

$\frac{2474}{1.334} = 1854°$ = theoretical combustion temperature in degrees centigrade = 3369° F.

We see that one volume of this gas will give .523 volumes of water vapor, and from Table III, that if we expect to raise one litre of water vapor from zero centigrade to 1850°, that there will be required as the *mean* value .581 calories for each degree. There will, therefore, be required in this case a mean of .304 calories to raise the water vapor derived from the combustion of one litre of this gas each degree from zero to 1850. Determining in the same way the heat required for the proper volumes of carbon dioxide and nitrogen, we find that 1.334 calories will be the mean amount of heat required to raise the total products of combustion each degree from zero to 1850. We have available to heat these gases 2474 calories, and the theoretical temperature would therefore be 1854° C. The proper specific heat to be used (in this case for 1850°) may only be found by trial.

Combustion in the theoretical amount of air is a condition never attained in practice. There is almost always an excess of air present, the amount of which may be calculated from the analysis of the gases after combustion. Knowing this, we may calculate the highest temperature possible with our given conditions. As an illustration, let us assume that when working with this water gas we find the following as the analysis of the gases after combustion :

Carbon dioxide	CO_2	16.27 %
Oxygen	O_2	4.15
Nitrogen	N_2	79.57

Each volume of this gas contains .0415 volumes of oxygen, which will be accompanied by $.0415 \times 3.784 = .157$ volumes of nitrogen from the air. Deducting this amount plus the .02 volumes of nitrogen present in the original gas from the total .796 volumes of nitrogen, we find .619 volumes of nitrogen corresponding to the oxygen actually used for combustion. The .157 volumes, therefore, represent the excess of air and the .619 volumes the air theoretically necessary. The ratio between these shows that there was 25.4 per cent. excess of air present.

We may now calculate the maximum combustion temperature attainable under these conditions.

Percentage Comp. of Gas.	Volume in Litres.	Vol. Oxygen Required for Combustion.	Volume of Products of Combustion.			
			Water Vapor.	Carbon Dioxide.	Nitrogen.	Oxygen.
CO_2 4.4	.044	0	0	.044	0	0
O_2 .3	.003	0	0	0	0	0
CO 41.0	.410	.205	0	.410	.775	0
H_2 52.3	.523	.261	.523	0	.988	0
N_2 2.0	.020	0	0	0	.020	0
25.4% air in excess		0	0	0	.448	.118
		.466	.523	.454	2.231	.118
Deduct O_2 already present		.003	Deduct for .003 O_2		.011	
		.463			2.220	

Using volumetric specific heats at constant pressure. (*Table III.*)

.523 × sp. ht. H_2O at 1650° (= .556) = .291
.454 × sp. ht. CO_2 at " (= .663) = .301
2.220 × sp. ht. N_2 at " (= .391) = .868
.118 × sp. ht. O_2 at " (= .391) = .046

1.506

$$\frac{2474}{1.506} = 1643° \text{ C} = 2989° \text{ F.}$$

In the same way it may be calculated that for a fifty per cent. excess of air the maximum temperatures will be 1470° C = 2678° F.

In the preceding cases it has been assumed that the combustion took place at constant pressure. In a gas engine, where the explosion takes place approximately at constant *volume*, the theoretical temperature will be somewhat higher, due to the lower specific heats. Referring to Table I, where the volumetric specific heats at *constant volume* are given, we may calculate

.523 × sp. ht. H_2O at 2100° (= .526) = .275
.454 × " CO_2 " (= .653) = .296
1.772 × " N_2 " (= .328) = .582

1.153

$$\frac{2474}{1.153} = 2145° \text{ C.}$$

The temperature which may theoretically be obtained in a gas engine is, therefore, with this gas nearly 300° C. higher than when burned in the open air.

The following calculation of the temperature obtained from a carburetted water gas is an example of a more complicated case.

Theoretical Flame Temperature of Carburetted Water Gas.

Percentage Composition of Gas.	Volume in litres.	Water Vapor.	Carbon Dioxide.	Nitrogen.
.12 C_6H_6	.0012	.0036	.0072	.0340
14.12 $\left\{\begin{matrix}C_2H_4\\C_3H_6\end{matrix}\right\}$*	.1412	.3530	.3530	2.0008
1.72 O_2	.0172	.0	.0	.0
25.30 CO	.2530	.0	.2530	.4781
22.40 CH_4	.2240	.4480	.2240	1.6934
28.30 H_2	.2830	.2830	.0	.5349
8.04 N_2	.0804	.0	.0	.0804
	1.0000	1.0876	.8372	4.8216
		Deduct for .0172 O_2		.0651
				4.7565

Using volumetric specific heats at constant pressure.

.8372 × sp. ht. CO_2 at 1900° (=.706) = .5910
1.0876 × sp. ht. H_2O at 1900° (=.588) = .6395
4.7565 × sp. ht. N_2 at 1900° (=.404) =1.9216

3.1521

Net heating value = 673 B. T. U. per cubic foot (experimental value) = 5990 calories per litre.

$\frac{5990}{3.1521}$ = 1900 = theoretical combustion temperature in degrees C.

* The assumption is made that the unsaturated hydrocarbons are made up of ethylene and propylene in equal volumes.

Using specific heats at constant volume.

$$\begin{aligned} .8372 \times \text{sp. ht. } CO_2 \text{ at } 2200^\circ\ (= .671) &= .5617 \\ 1.0876 \times \text{sp. ht. } H_2O \text{ at } 2200^\circ\ (= .539) &= .5862 \\ 4.7565 \times \text{sp. ht. } N_2 \text{ at } 2200^\circ\ (= .333) &= 1.5839 \\ & \quad 2.7318 \end{aligned}$$

$$\frac{5990}{2.73} = 2190^\circ \text{ C} = 3974^\circ \text{ F.}$$

The following calculations are for a theoretically perfect blast furnace gas of 33% CO and 67% N_2, volume of products of combustion .33 volume CO_2 and 1.297 N_2.

Using volumetric specific heats at constant volume.

$$\begin{aligned} .33 \times \text{sp. ht. } CO_2 \text{ at } 1700^\circ\ (= .584) &= .1927 \\ 1.297 \times \text{sp. ht. } N_2 \text{ at } 1700^\circ\ (= .306) &= .3969 \\ & \quad .5896 \end{aligned}$$

Net heating value 111 B. T. U. per cubic foot.
= 991 calories per litre.

$$\frac{991}{.5896} = 1690^\circ \text{ C.}$$

When considering the relation which these temperatures thus calculated bear to those actually obtained, we may take into account, first, the influence of dissociation of the carbon dioxide and water vapor at high temperatures. The extent of this dissociation has been summed up by Nernst in his *Theoretical Chemistry* from Le Chatelier's work as follows:

"In the smelting furnace the temperature only extends to about 2000° C. and the partial pressure of carbon dioxide only amounts to about 0.2 of an atmosphere; now, the carbon dioxide is decomposed only to about five per cent., whereby the capacity of the furnace for work is somewhat diminished, though not very much. With explosives, the temperature of combustion rarely rises above 2500° C. and never reaches 3000°. Inasmuch as the pressure of the carbon dioxide is here estimated in thousands of atmospheres, dissociation has no influence."

It is not easy to assign any definite value to the influence of the other factors which prevent the attainment of the full theoretical temperature. The heat liberated never goes

completely to raising the temperature of the combustion gases, but there are nearly always local points where the heat is almost entirely utilized in this way. In the case of a Bunsen burner flame, the highest temperature found by the author experimentally was 1780° C., while the temperature calculated was 1850° C. Though the calculated temperatures are always somewhat high, they afford valuable information.

Some conversion factors.

1 calorie = 3.968 British thermal units.
1 small calorie = .003968 British thermal units.
1 calorie per litre = 112.36 B. T. U. per cubic foot.
1 small calorie per litre = .11236 B. T. U. per cubic foot.
1 small calorie per litre = 1 large calorie per cubic metre.

THE PRESIDENT:—Gentlemen, you have heard this very interesting and instructive address on gas engines by Mr. White. Are there any questions you would like to ask him?

MR. ALFRED E. FORSTALL (Montclair, N. J.):—Mr. White stated that the reason why the efficiency of the blast furnace gas was greater than the efficiency of the water gas is that it can be compressed to a higher temperature. The point strikes me that it is not perfectly clear how the extra work of compression is compensated for. I think I would like him to explain that.

MR. WHITE:—I have explained that in the paper. So long as you are considering an actual gas engine running, there will be a loss of work in compressing the gas; but if you consider there is no loss of heat in compressing the air or gas, which expands again, you will see that you will get all the work back. If you have a water jacket, and the gas has cooled off, of course there is some loss of heat. Of course, if you have the ten atmospheres of compression plus the seven atmospheres, there will be an actual pressure of seventeen atmospheres in the cylinder, but only seven atmospheres due to explosion of the compressed charge.

MR. W. CULLEN MORRIS (Long Island City, N. Y.):—As I understand Mr. White, in comparing the several gases he

only compressed the blast furnace gas and not the carburetted water-gas. I ask him if the carburetted water-gas were compressed, would its efficiency be increased?

MR. WHITE:—Its efficiency would rise. If the pressure is increased to five atmospheres, its explosion pressure would go up, I should say, to nearly nine atmospheres.

MR. HENRY L. DOHERTY (New York City):—I want to congratulate the Association on taking up a matter which I believe is of the greatest importance in engineering work. I have absolute faith in the future of the gas engine. We have a central station at Madison, Wis., which is now generating one-half of its current by gas engines. We have another at Long Branch which will generate more than half the current capacity of the station by gas engines. At Long Branch we have put in producer gas engines and intend to use producer gas. I think some of the reputable builders of producer gas machines and gas engines are now ready to guarantee—if you do not make the guarantee too rigid—that they will give you a brake horse power for one pound of coal.

I have been interested in Mr. White's lecture. In the first place he gives the calorific value of blast furnace gas as 111—by that I mean per cubic foot—that would mean practically no CO_2, and you do not get that efficiency in blast furnace gas. I understand the Koerting engines at the Lackawanna Steel Works get gas of 18 B. T. U. per cubic foot, and it is hardly reasonable to suppose that the blast furnace gas there would contain as a maximum more than 70 and probably down as low as 50; because they would force the blast with the idea of getting a higher fuel economy without endangering their charge by the presence of free oxygen.

Mr. Donald McDonald in a remark just made to me compliments Mr. White on his curves. He says the only curves he could ever get for gas engines look like a mule kicking up behind. I do not get anything like that. I could not verify the figures given by Mr. White. I was rather surprised at the figures he put upon the blackboard, and was a little surprised at his statement of the increased temperature due to adiabatic compression, or nearly adiabatic compression, of ten

atmospheres. I am surprised that does not add more than 500°.

As a matter of interest I want to call the attention of the members to a publication by Mr. Humphrey, of England. It is a very comprehensive bit of literature—I do not know what you would call it—on large gas engines, and if anyone is interested in the subject they should look it up in that book, because our text books are behind the times as regards gas engines. The Diesel motor, which is the one called a rational heat motor, I do not think has been a success in this country. I understand they have been trying abroad to work a 100 horse power engine with crude oil, and it was a failure, and we have been anxious to hear more about it.

I was rather sorry that Mr. White did not touch upon the relation between the efficiency of the gas engine and the efficiency of the steam engine, and go into the reasons why both are limited, and why the gas engine has such wonderful possibilities. If we were to figure that we were limited to the flame temperature of lubrication, which most people think we are, the gas engine efficiency would not be as high as it is now ; but we can retain a hot core of gas in the centre of the cylinder, and we cannot do it with steam ; for as soon as steam condenses the hot core goes to the cylinder walls, and owing to the greater possibility in the gas engine it seems to me fitting the gas men should be much more interested in the subject of gas engines than they apparently are at present.

THE PRESIDENT :—Gentlemen, are there any further questions to be asked on this subject?

Mr. White, I wish to thank you in the name of the Association for your kindness in presenting this paper to us. We will now go into Executive Session, as there is some special work which we desire to take up.

(The meeting then adjourned to Executive Session.)

THE PRESIDENT :—We will now resume the open session. The next order of business is a paper by Mr. W. C. Morris, of Long Island City, N. Y., on "Notes on the Operation of Large Carburetted Water-Gas Sets."

(For paper see Appendix, page lxiv.)

THE PRESIDENT:—Gentlemen, you have heard the very interesting and very carefully worked out paper presented by Mr. Morris. We shall be glad to hear from some of the members on the subject. I understand that Mr. William E. McKay, of Boston, Mass., has sent in a written discussion on the subject, which the Secretary will read.

MR. WM. E. MCKAY (written discussion read by the Secretary):—Mr. Morris' statement of the results from large water-gas sets has a particular interest, because of the practical examination of the amount of steam used. For the efficient operation of Lowe apparatus, an exact determination of the quantity of steam admitted to the generator, and of the "excess steam," or steam not decomposed by passing through the generator fuel, is of importance, whether the sets be large or small. In a paper read before this Association in October, 1890, by Mr. A. G. Glasgow, the author stated that the theory of fuel economy in the manufacture of water-gas lay in a series of apothegms, of which one was as follows:

"Never admit an excess of steam."

A comparison of the guaranteed capacity of a setting of given size and construction at the present time, with the capacity guaranteed some years ago, will show an increase in the capacity that may be partly attributed to a better knowledge of the steam supply.

The accuracy of determination of temperatures of the generator fires may, perhaps, sometimes be doubted; but there is no difficulty in measuring the steam used, and if the amount of steam used per 1,000 cubic feet be set down, along with the daily items of coal and oil per 1,000, a relation between them will be evident. The three quantities to be determined are:

1. The amount of steam admitted to the generator per unit of time under known conditions of pressure and valve opening.

2. The amount of steam decomposed, and present in the finished gas.

3. The amount of "excess steam"—that is, steam admitted to the generator and not decomposed—per 1,000 cubic feet of gas.

When any two of these are known the third is a sum or difference.

To determine the rate of flow of steam admitted to the generator, I have made satisfactory use of the following: The steam pipe is disconnected from the generator shell and immersed in a cask containing a known weight of water (the cask sets upon a portable scales) so that the steam-pipe dips in the water by the number of inches corresponding to the gas pressure in the generator when and where the steam is admitted. The total length of steam-piping and total number of turns correspond with the conditions of generator supply. The steam-valve operated by the gas-maker is then opened an observed number of turns, and the quantity of steam flowing into the cask per unit of time is read on the scale-beam. Separate determinations are made of the upper and lower steam supplies to the generator. The rates thus found may be taken as *approximately* correct for conditions of actual generator use.

The steam decomposed, and so present in the finished gas, is learned from an analysis of the gas, as stated by Mr. Morris. The water-vapor present in the finished gas is indicated by the temperature.

A direct measure of the "excess steam" used per 1,000 cubic feet of gas made is effected by collecting all the condensation (tar and water) that occurs. If no water is introduced into the system between carburetter and holder, the water condensed and measured gives directly the data for the "excess steam" used in generator. This figure is the one most easily and accurately ascertained, and it furnishes a constant check upon the operation of the generators.

I find that the "excess steam," as determined by actual measurement of collected condensation, is about ten per cent. less than the amount that would be found by deducting the steam decomposed per 1,000 from the steam admitted to generator as calculated from a calibrated valve-opening.

It is doubtless nearly correct to assume the amount of steam dissociated as about 15.4 or 15.5 lbs. per 1,000 cubic feet of final gas. If this amount is deducted from the figures for the total steam per 1,000 cubic feet, as given in Mr. Morris' *Table No. I*, the net "excess steam" per 1,000 cubic feet would appear thus, for the several tests reported :

	Excess Steam.		Excess Steam.
A	4.34 lbs.	E	12.44 lbs.
B	8.69 "	F	14.81 "
C	9.37 "	G	8.53 "
D	11.15 "		

The "costs per 1,000 cubic feet," as given in Mr. Morris' *Table No. II*, appear to vary directly as the "excess steam," rising or falling as this latter rises or falls. Mr. Morris prevents an erroneous deduction from this similarity in variation by adding that "other factors should enter into our consideration of these figures." There are so many elements in gas-making, the variation of which affects the net result, that a statement of the best rate of flow for the generator steam is a statement of a temporary and mutable compromise. In 1891, with a type of water-gas apparatus arranged only for making gas with up-steam runs, I found the average "excess steam" was 16.2 lbs. per 1,000, when we were getting the best net results from the set.

With apparatus similar to that described by Mr. Morris, but with generators having an inside diameter of only 6′ 6″, careful tests have recently been made when we were getting especially good fuel and oil results, and showed about thus:

Fuel.	Enricher.	Amount Gas Averaged.	"Excess Steam."
Anthracite	Naphtha	25,000,000	13.5 lbs.
Anthracite	Gas-Oil	25,000,000	10.5 lbs.
Anthracite	Gas-Oil (heavy)	90,000,000	13.0 lbs.

On the above tests the make per square foot of grate per hour ran from 1500 to 1800 cubic feet.

I have usually observed that a marked variation in the rate of flow of the steam has been followed by a variation in the CO_2, accompanying, however, a change in the temperature of

the generator fires. It has been my experience that the temperature of the fire is directly affected by the amount of steam used—the "excess steam" carrying away from the generator fire much heat that later performed some useful work. Steam will carry heat from the generator and give it up in the carburetter and superheater, by an amount dependent upon the temperatures of the generator fire and of the gas leaving the superheater. Steam will carry to waste an amount of heat dependent upon the temperature of the carburetted gas leaving the superheater. Suppose that steam enters the generator at 331° F., and that the carburetted gas leaves the superheater at 1450° F., then each pound of undecomposed steam will carry from the superheater about 537 B. T. U., and if the excess steam was as much as 14.8 lbs. (case F, cited by Mr. Morris), the heat thus carried to waste would be nearly 8,000 B. T. U. per 1,000 cubic feet of gas made, or about one-twelfth of the energy required for the decomposition of the steam appearing in the finished gas. On the other hand, this steam has played an important part in protecting the enriching oil, and in graduating its gasification, as well as in receiving between 2000 and 2500 B. T. U. from the generator fuel and transferring it to the enriching oils. The effect of the free steam in the carburetter is serviceable in other ways than in prevention of over-cracking, to which Mr. Morris refers; there is some reason for supposing that the "excess steam" influences the amount of sulphur found in the gas at inlet to purifiers, both as to the amount of sulphur and as to the chemical form in which the sulphur is found. It is so difficult to keep all but one of the many circumstances of gas-making at a standard, for the purpose of observing the effects of change in the one variable, that it is frequently difficult to ascribe an effect to the right cause, and the obscure relation between "excess steam" and observed products in water-gas making require careful work to make their definition other than suppositious.

The "excess steam" immediately affects the condition of the generator fires for cleaning. Too little steam will fill the bottom of generator with clinker (especially with a high blast pressure), and too much steam will have a contrary, and

equally objectionable, effect. On an 8′ 6″ setting, with an excess of 80% steam, it usually requires 25 to 35 minutes for the actual cleaning of an anthracite fire, cleaning once in about 12 hours, and the total time between the last run-off before the cleaning and the first run-on after the cleaning is 60 to 70 minutes.

The manner in which steam is introduced into the generator, whether for up or down runs, has an effect on the fire that appears in the average make of gas; it is easy to start a "dead-hole" if the steam is not admitted properly. One point on which I hope Mr. Morris will enlighten us is the following:

The steam-pressure he reports in the tests A to F reads 50 to 90 lbs.; this pressure is, as I understand it, read on a gauge placed between the valve operated by the gas-maker and a calibrated steam-cock that is not ordinarily changed. Under these circumstances, even if he has constantly made use of an initial high pressure of steam at the boilers, yet the pressure in the section of pipe between the steam-valve and the steam-cock runs as high as 90 lbs. and as low as 50 lbs. Why is it that a similar difference of 40 lbs. *boiler-pressure* in the steam supply has such a great effect on the gas-making [capacity and economy], when in each case the steam, as distributed over the bottom or top of the generator, shows a pressure of only a little more or less than a half-pound [15 to 25 inches on the water-gauge]? The temperature of steam at 90 lbs. may be 331° F., and at 50 lbs. 299° F., and the difference of "total heat" would account for about 10 B. T. U. per lb. of steam entering the generator. If 24 lbs. steam were used per 1,000, there would be a total difference of 240 B. T. U. between the heat carried into the generator per 1,000 by the steam under 90 lbs. boiler pressure and the steam under 50 lbs. pressure; yet with steam at 50 lbs. boiler pressure the results from the generator fires would be wholly and absolutely unsatisfactory as compared with what can be done with steam of higher boiler pressure. I refer, in each instance, to steam that is dry, but not superheated.

THE PRESIDENT :—Has Mr. Norcross any remarks to make on this subject? If Mr. Norcross is not present we would like to hear from Mr. Norris.

MR. ROLLIN NORRIS (Philadelphia, Pa.) :—Mr. President, I do not know that I can add anything of particular value to this discussion except to say in a general way that in such experimental figures as I have, the amount of steam used per 1,000 cubic feet agrees quite closely with the figures given in Mr. Morris' paper; in other words, under the best practical working conditions, the excess steam used in the generator runs about 100%.

I am impressed, however, with the importance of having some accurate working method of keeping the amount of steam admitted to the generator at the rate desired. Ordinarily the steam is admitted to the generator by the gas-maker, who opens his steam valve a certain number of turns. The valve seat wears out and the gas-maker continues to open the valve the same number of turns, and, of course, the quantity of steam admitted must vary. With the renewal of the valve, possibly of a different make, the steam again varies; and I like that suggestion made by Mr. Morris, which is to have a definite opening, determined by means of a cock located between the operating steam valve and the generators, and then have the gas-maker by means of a gauge maintain a certain pre-determined pressure on this fixed opening.

There is one thing I would like to ask Mr. Morris, which does not bear directly on the steam, and that is what advantage he finds in reversing the up and down runs during each run? The ordinary method of operating reverse steam apparatus is, of course, to make so many up-runs and then a down-run, usually two up-runs to one down, or one up-run to one down-run. In the experiments detailed, the effect of reversing the valves in the middle of the run is to produce practically one up-run to one down-run, each of half the ordinary length.

MR. EDWARD H. EARNSHAW (Philadelphia, Pa.) :—I do not think I can add anything to what Mr. Morris has said in regard to the use of excessive steam; but referring to the

early part of the paper, taking up the tables and experiments quoted by Mr. Morris, I would make the suggestion that Dr. Bunte's results, and those obtained by Strache and Jahoda are perhaps more in accord than Mr. Morris has given them credit for being. In the first two experiments in the table of Messrs. Strache and Jahoda the rate of steam flow is excessively small, and under these circumstances we can easily imagine that a considerable reduction of CO_2 might occur in passing through the fire. In the experiments of Dr. Bunte, while he does not say so, the inference is that the rate of flow of steam is the same in all cases, so that if we select from the table of Strache and Jahoda those experiments where the temperature of the fire is quoted, and omit the first two where the rate of flow of steam is abnormally small, we would obtain a comparison as follows :

	Temperature of Fire.	Decomposed Steam.	Carbonic Acid.
Dr. Bunte	954°	27.2%	6. 8%
Strache and Jahoda	895°	34.1%	6.85%

which, I think, is a comparison well within experimental error.

I agree very fully with the statement which Mr. Morris makes at the end of his paper that the temperature of the fire is of much more importance in determining the composition of the gas than the rate of flow of steam within the limits usually applied to water-gas practice.

Mr. Isaac N. Knapp (Ardmore, Pa.) :—I would like to say a word on the mechanical difficulty of getting an even distribution of the steam in the bottom of a large set. I think that in operating 11 foot sets you will find usually there is one point in the generator where the brick work will give out rapidly, unless the steam is properly distributed, and you will have to watch the set very closely. If you find any point on the surface of the grate where clinker is made in an undue proportion, or if there is any place that it does not make, you will discover that the fault is that the steam is not properly distributed. To get good results out of a large set it is very important to get an even distribution of the steam, so that

when you open your fire door you want to find that the fire has gone down uniformly, which will be indicated by the ash and clinker forming uniformly over the whole grate surface. When you have that condition you are in shape to get good results, but if the fire is uneven in burning down, then you cannot get good results.

THE PRESIDENT :—Are there any further remarks or questions to be asked of Mr. Morris?

MR. THOMAS D. MILLER (New Orleans, La.) :—I would ask Mr. Morris what kind of coal was used in these tests? The clinker at the top was a troublesome experience that I had. I ask what was the size of coal, and what grade; was it broken, or stove size, and was it soft or hard anthracite coal? I think it is a great misfortune that we cannot know the temperature of the generators at the time the test was made. According to the table, when the temperature was 954°, the CO was 39.3 and CO_2 6.8. The next lower temperature the percentage is CO 18.1 and CO_2 21.9. As soon as you get to a temperature of 1010° C., 1850° F., the percentage of CO is 49.7 and the percentage of CO_2 is 1.5; in other words, at about 1000° C. you have reached the critical point, and beyond that gain nothing by increasing the temperature, and below it you lose a great deal. You manufacture carbonic acid very rapidly below that temperature, and it does not diminish at all rapidly above that temperature, and I have always made it a rule to try to maintain as near 1800° F. in the generator as I could, after various experiments to find what conditions gave these results, and it may be that unless the temperature was the same, some of the differences in results obtained here might be attributed to the fact that you did not have the same temperature under varying conditions.

THE PRESIDENT :—If there are no further remarks Mr. Morris will be given an opportunity to reply.

MR. W. CULLEN MORRIS (Long Island City, N. Y.) :—In summing up the discussion, I should first make reply to Mr. McKay, who presented a written discussion. Generally speaking, there is not much reply to be made to Mr. McKay,

except in the last part of his paper, where he said: "Why is it that a similar difference of 40 lbs. *boiler pressure* in the steam supply has such a great effect on the gas making (capacity and economy), when in each case the steam, as distributed over the bottom or top of the generator shows a pressure of only a little more or less than a half pound (15 to 25 inches on the water gauge)? The temperature of steam at 90 lbs. may be 331° F., and at 50 lbs. 299° F., and the difference of 'total heat' would account for about 10 B. T. U. per lb. of steam entering the generator. If 24 lbs. of steam were used per 1,000, there would be a total difference of 240 B. T. U. between the heat carried into the generator per 1,000 with the steam under 90 lbs. boiler pressure and the steam under 50 lbs. boiler pressure; yet with steam at 50 lbs. boiler pressure the results from the generator fires would be wholly and absolutely unsatisfactory as compared with what can be done with steam of higher boiler pressure." In regard to that, I am free to admit that the data which I have is not sufficient to work to such a close quantity as 240 B. T. U., and I think that the difference in make on the machine would not show any very appreciable difference on the pressure gauge at the outlet of the machine, as the make per square foot only differs from the highest to the lowest seven per cent. In the early part of Mr. McKay's paper, where he refers to the rather high make of 1800 cubic feet per square foot of grate, he has not stated any pressure of the blast, and the make per square foot of grate per hour is largely governed by the pressure of the blast under the fires. For instance, in one case on 11 foot machines we raised our pressure from 21 inches to 25 inches, increasing the make on these machines from 1,800,000 up to 2,250,000 a day, the increase being due to the shortness of the blow and the greater number of runs per hour. I think that will explain the difference in that case.

Mr. Norris asked what were the advantages of reversing the direction of the steam on each run. I think the question can be answered in general terms that it is an increase of the advantage that is obtained by reversing the direction of the steam at different runs. We reverse the direction of the steam

every second or third run, in some cases, because we want to obtain a uniform condition of the fires. I find in running our sets that, with the grade of coal that we have, a more uniform condition of the fires can be obtained by reversing the steam in the middle of the run, or part of the run, making the period of the reverse such that the deposition of clinker, if there is any, shall be made at the point in the shell where it can be removed easiest.

Mr. Earnshaw referred to there being a greater agreement between the results of the Strache and Jahoda paper and the Harris paper. It still seems to me that there should be a greater agreement between the two authorities than there is for a difference of temperature of only 20° C., and it is hard to understand why there should be a difference of over 15 per cent. in the amount of carbonic acid formed.

Mr. Knapp referred to the distribution of steam underneath the generator, and I agree with him that it is essential ; but I do not think that any of us would be able to run a set with an improper distribution of steam under the generators for a very long time, as the coal consumption would show such an increase over proper running that it would be disastrous to good results.

Mr. Miller referred to the quality of the coal used in our tests. We are supplied with Lehigh and Wilkesbarre coal, known as "Wyoming" coal. Its constituents are as follows : Moisture, 2.37 ; volatile matter, 5.81 ; fixed carbon, 81.18 ; ash, 10.61.

In regard to the temperature of the fire, I am free to admit I have no figures on the temperature of the fire in these particular tests. We have at our works several times endeavored to get satisfactory results with pyrometers, but have never been able to get anything on generator temperatures that was satisfactory.

The President :—Mr. Morris, in the name of the Association, I thank you for your paper.

The time has now come for a recess, and we will adjourn until 2:30 o'clock.

SECOND DAY—SECOND SESSION.

President Miller called the meeting to order at 2:30 o'clock.

THE PRESIDENT :—We have here two letters bearing on the question of the prevention of the fluctuation in pressure in the gas mains, due to gas engines. If there is no objection we will publish these with the minutes and not read them to you. Hearing no objection, it is so ordered.*

THE SECRETARY :—I have here a question which was put in the question box. It is as follows : "What is a cheap and efficient way of separating the water from carburetted water-gas tar at a small gas works?"

THE PRESIDENT :—Does anyone wish to make any remarks or suggestions on this question? If not, I suppose the best thing to do is to refer the gentleman to the questions and answers in the Practical Class. That subject has been gone through there at great length, and if he will study up those questions and answers I think he will have no trouble in getting all the information he desires relating to the question which he asks.

THE SECRETARY :—We have another question : "Wanted —A statement of experience in the use of the so-called gas arc-lamp, and opinions as to its value to the gas industry."

THE PRESIDENT :—We would like to hear something on that subject.

A MEMBER :—Refer to the President's Address.

THE PRESIDENT :—Apparently the majority of the members do not agree with the position taken by the President on that question. The gentleman who offered this question possibly put it in to bring that subject up.

MR. EDWARD G. PRATT (Milwaukee, Wis.) :—I have no doubt that the position taken by the President in his Address is correct theoretically, but in practice I think I would be compelled to take some exception to it. I think in our business

* These letters are printed with the other written answers to the question.

it is our duty to look after those things which are to our best interests. It seems to me that in the utilization, and in the recommendation of the use of the so-called gas arc-lamp, we have something which enables us to meet the competition of the electric arc-lamp. It seems to appeal to the light user, and to a great extent enables us to successfully compete with the electric arc-lamp.

I agree with what the President said in his Presidential Address, that from the standpoint of efficiency and the better distribution of light, there is no question that a number of incandescent lamps is probably more efficient than the same number of burners enclosed or grouped in the arc-lamp ; but I am sure the arc-lamp fills a much-needed want, for it enables us to compete effectually with the electric arc, and to a great extent, as is borne out by the facts, the gas arc-lamp is taking the place of the electric arc because it appeals to the user of light. For that reason I think it is one of the best mediums that we have had presented to us by the means of which we are able to compete with electricity for store lighting and the lighting of large areas successfully.

Mr. Thomas D. Miller (New Orleans, La.) :—Wherever my friend Pratt leads I am willing to follow. I was not here this morning when the Report of the Committee on the President's Address was made. The President's remarks in regard to the gas arc-lamp reminds me of something that has come up in my experience, where a man said, "I am going to fire that fellow and teach him a lesson." My remark was, "That is a doubtful way of teaching him a lesson—teaching it to him and then discharging him so that some other fellow could get the benefit of it." If it is wrong practice to encourage the use of the arc-lamp, because it is bad in principle, and you refuse to supply a customer with the lamp just because it is bad in principle, who is going to get the benefit of it? Certainly you will not, and by the time he is educated up to the point you want him to reach, he is probably dead and gone and there is another consumer in his place ; and therefore I am decidedly of the opinion that the proper thing to do is to supply the needs of your customers—educate them if you

can, but if you cannot, supply them with what they want. There is no question but what electricity, after all, in view of the tendency of the American people to go to something new, has created a demand for the arc-lamp which we are supplying with the gas arc.

I am sorry I was not here when the Report of the Committee on the President's Address was read. I hope it was along right lines. The President's remarks applied to the laboratory and not to the commercial end of the business, because our business as managers is to supply the public with what they want, and our business as engineers is to educate the public to the ideal. When it comes to the practical thing of educating the people to the ideal, those who have given the matter much thought know that the ideal is never attained —it is all right to aim high, but to get as near the mark as you can is the principle on which the commercial end of the business must be run.

Mr. G. W. Clabaugh (Omaha, Neb.) :—I agree thoroughly with what the gentleman has just said. I think the President's remarks were all right technically, but not commercially. I think if we follow him and agree that it is not wise to put out the arc-lamp, while we are running a kindergarten the electric light company across the street will be turning out graduates. They will get the business. We want the business now. A few years ago we had the open flame burners. When we were losing business by the introduction of the electric incandescent light, the Welsbach burner came to our assistance to shut out the incandescent; then the electric people produced the arc. We had our incandescents scattered in the stores, just as the President suggests it, in which position they would give more light probably, and then the gas arc-lamp came out as a competitor of the electric arc.

If our customers were to come to us and ask us to give them the most efficient light for the least money in the fitting up of their places, and they would be satisfied with what we would recommend, it would probably be a good thing for us to put on long-arm fixtures and have the separate lights; but

how many of us have customers of that kind. They have seen these gas-arcs and they want them. Our customers say that the gas-arc is the greatest thing they have ever seen in their lives. There are not many laymen who can tell much about the candle-power, about the life, etc.; they only know it is better than the electric arc at half the cost of running. That is one of the greatest factors in our favor, and, as Mr. Miller has said, the people want it, and we should sell it to them. I believe in giving every customer all we possibly can for his money; but if we tell him that this arc will not give him quite as much light as the open burner, he will say: "Oh, yes, I have been using the open burner, but my next-door neighbor has the arc; it looks better, and I would like to have it." If we try to convince him that the gas arc is not as good as the single burners, he will go away, and in a week or two we will probably see an electric arc in his store. We do not want to miss anybody who wishes to purchase light. It is not a question of religion, or creeds, or anything of the kind—we must sell to everybody. Some man may think that homœopathy will do him more good than the old school of medicine. We must give people what they want—if they want the arc light they should have it, and it is no part of our business to endeavor to have them take something else.

There is no question, I think, that the Welsbach people with their mantle should follow up this arc light, and be able to tell us something about the different kinds of mantles to be used in them. I ran up against a test the other day with the Nernst electric lamp. They had twenty-four electric arcs in one store, and it was one of the best points at which to advertise in the city. We were anxious to have our lamps in this store. They put in twelve of the Nernst lamps in competition with eight of our gas arcs; and while probably the eight gas arcs did not give as much light as the twelve Nernst lamps, the eight gas arcs would certainly give more than eight of the Nernst lamps, and I think as much as ten. It was a gentlemen's furnishing store, and they claimed they could not show their colors as well with our lamps as with the Nernst, and a test was proposed. I witnessed the test. It was put up very fairly. They had some very heavy black cloth hang-

ing down, our light on one side and the electric light on the other. They brought out some delicate shades of blue, and the tinge of yellow in our light coming in contact with the blue made a most beautiful green. A pink handkerchief put against the black ground under our light looked as if it was saffron. That was one time in my life when I thought that silence was golden—I did not say a word. On the other side of the cloth the colors were most perfect, as perfect as the daylight would show them. They brought out a suit of black clothes. Under our light the cloth in the clothes was black; but under the Nernst light it was blue—the bluish white of the Nernst lamp made the cloth look blue. That might not be a serious matter, unless a man was going to a funeral. Then they put a dark blue suit of clothes under their lamp, and it looked like a suit of light blue. As our light had shown the black perfectly, I gave a sort of sickly grin; but when they put the blue clothes under our lamp it looked black, so I didn't see that I had gained anything. I took the matter up with the Welsbach people, and told them the conditions, and told them I wanted a white light. I got a most courteous letter, in which they told me I had a white light; but I answered that I saw the yellow tinge in the light, and I again asked them to send me a white light. They sent me a No. 193, and also a No. 2 mantle. They said that the No. 2 was the light I would want, as it had a slight tinge. I put up the No. 193, and I want to say that we can show colors as beautifully as the Nernst light, or as beautifully as colors can be shown by sunlight or any other light. If the proper mantles are used in the arc lamps, while the candle-power may not be distributed as efficiently as in the four corners of the open burner, the lamp is attractive in its appearance, it is something new, and the people are everlastingly looking for something new.

As to any injury resulting to our business from the use of the lamp, I cannot possibly see how it can ever do us any harm—I cannot see how it is possible to do it—because when they are through with this lamp there will be something better on the market which the people will take up. It is only a few years ago that we had the Siemens-Lungren burner. I put them out and kept them on a year

and a half, until the Welsbach was perfected. I do not think we injured the gas business because we put out the Siemens-Lungren lamps. We might say the same thing about the lava tip. We give a man a five foot lava tip. We know it burns five feet efficiently; but it may pass ten feet of gas through the tip. We are trying to overcome that by putting on Bray burners and doing everything in our power to help our consumers to burn gas economically and efficiently. If we stand back when these new things come into the market and say, "No, it is not a good thing to sell, because it is not as efficient as it should be," it is my opinion that the electric light companies will have all our business whilst we are experimenting, and then we will have a good time to get the business away from them when we have perfected something. Let us go on experimenting and improve these arc lamps to a higher state of efficiency; but, in the meantime, let those which we now have bring us an income in the consumption of gas in our consumers' places.

Mr. Norris took the Chair.

THE CHAIRMAN:—President Miller desires to make some remarks in reply to what has been said. Before he begins, is there anyone else who wishes to speak on this subject?

MR. IRVIN BUTTERWORTH (Detroit, Mich.):—I was on the Committee on the President's Address, and as a member of the Committee signed the Committee's Report, in which the Committee ventures to criticise Mr. Miller's opinion as expressed in his address. I would like to read a statement which I have prepared, which will more fully express my individual opinions for whatever they may be worth.

I venture to respectfully take issue somewhat with our President's strictures on those gas companies that are countenancing, or even encouraging, the use of the so-called gas "arc" lamps. I believe that our interests lie in the direction of endeavoring to provide our consumers with the kind of lamps that they want. It is a commercial and not a scientific requirement that is to be met. Consumers desire, first, certain forms of lamps, or certain lighting arrangements, that will enable them to do certain desirable things, and the ques-

tion of efficiency, in the sense of the maximum illumination per unit of gas, is really a secondary matter to them. If users of light were seeking simply the cheapest illumination, they would probably use oil, or even candles; whereas practically half the store illumination of the country is secured by means of electricity, the most expensive form of lighting now in use, proving that people are willing to pay more for what they want. The difference in efficiency between separate Welsbach burners and the so-called gas "arc" is not so great as to offset the advantages which the practical and shrewd merchant sees in the use of the latter. In other words, he knows what he wants, and we should try to give it to him; making the lamp that he desires, of course, as economical and efficient as possible, and also telling him frankly that separate burners would be still more economical, if that be true. These gas "arc" lamps are now so made, as we all know, that either one, two, three or four burners can be used at a time, as may be desired.

Mr. Alten S. Miller (Baltimore, Md.):—The evidence seems to be one way—the arguments these gentlemen use are the same arguments the yellow journals use for publishing the filthy matter we do not like to have in our houses—"the public demands it." That is the only argument I have heard yet. These gentlemen have all gone on the assumption in their arguments that they could not put a simple chandelier in a store where they put these (I hate to use the name) gas arcs. Is there any reason, gentlemen, why you cannot put in a simple chandelier with the same ease you can put in this fixture? Now, as to the injury to the business—the electricians are exercising a great deal of ingenuity and a great deal of good taste in ornamentation by electric lights. We must all acknowledge that electricity lends itself better to ornamentation than does gas. Now, the thing for us to do is to do the best we can with the materials which we have, instead of which we do just exactly the opposite. As long as we had no high candle gas burners we used to get up in these meetings and decry high candle lights. We said they were absolutely contrary to all the principles of lighting, and that no

one should use them—that people were doing their eyes an injury, doing themselves an injury, and doing the business an injury by using high candle lights. The minute we got them we went over on the other tack and brought them in with both hands. We leave these things in a man's store—things we would not put up in our own houses, because they are so hideously ugly.

I had a practical demonstration of this burner recently. We moved into a new office last January, and one of the supply companies asked if we would allow them to fit up our office with gas arcs. We had a lot of other things to do, and we did not give the matter much thought, and so let the company put in the gas arcs. The question came up as to whether the gas company would encourage the general introduction of the gas arc, and some of our people, who are interested in the commercial end of the business, took serious exception to the fact that I would not countenance the general introduction of the gas arc—that is, I would not encourage it. This Fall, when it came to the question of fitting up the office, I ordered the office fitted up with simple and cheap chandeliers, Welsbach burners, and rose-colored holophane globes. I do not think anyone would recognize it as the same office. While before it looked like a warehouse, after we made the change it looked like a gas office.

I do not think there is anything more to say, except to sum up what I have said—the only argument in favor of the arc lamp is that the public demands it. That is an argument in favor of selling opium. I think it will hurt our business, because the gas arcs are hideously ugly, and will in time prejudice the people against the use of gas. As has been already stated, it is a fad, and as soon as the fad is over the people will be prejudiced against gas. I cannot imagine a man who has any taste, and who has a thing like that in his office, going home and using gas as against electricity in lighting his house. The gas arc cannot help but prejudice him against gas for lighting. It is there all the time, an object lesson right in front of his face.

Mr. Thomas D. Miller (New Orleans, La.)—It is not usually regarded as the proper thing for a family to be divided

against itself, but I must take issue with my namesake, the honored President of this Association. He seems to have lost sight of one fact, which to me has always been a potent one—the electric arc emits its light from a point, almost a mathematical point. The gas arc emits its light from a surface almost infinitely larger. It emits a light which is diffusive, a light which approaches nearer to sunlight than any other artificial light, and the comparison is between the electric arc and the gas arc. The gas arc emits a light which is diffusive and illuminates, the electric arc emits a light which lights but does not illuminate. So far as the gas arc being hideous is concerned, I am afraid that my friend Miller has not had his art education carried out as far as his technical education. Technically he may be all right, but as an artist he is all wrong. As between two lights, one emitting a light which casts a black shadow and one which casts a penumbra, if I may be allowed to use the expression, there is no comparison between the two lights.

From the commercial point of view, and I have to handle both sides of the question, as I said in my previous remarks—and I must be pardoned for making a second talk on this subject—there is one point that has impressed me in the time I have been in the gas business, and that is that the gas consumer never changes. The gas man does; he grows older and passes away; the gas consumer does not. The gas consumer is continually coming in, new sets of recruits every year, and if you try to educate this generation you have to turn around and educate the next generation. In the meantime the fellow who is selling the electric light has come along and is doing the business, and that is what we are after. I tell you that you cannot look away from the fact that the man who is getting the income is the man who is making a success of life, and you cannot afford to figure on theory alone and ignore the practical side of a question like this. The practical side of the gas business to-day is represented by the man who can get the consumers and show the revenue. Am I right?

Mr. Alten S. Miller:—That is right.

MR. THOMAS D. MILLER (New Orleans, La.) :—So far as the educational part of this question is concerned, you can educate the next generation more easily than you can this, because you have more time in which to do it, and that is the whole gist of the argument. What is the good of educating a man who is not going to be your consumer, who is going to die and pass out of the way, and another man take his place? Our present consumers are likely to quit business and move to the country and go to farming, or do a number of other things which will remove them as consumers of our product, and it is all the same thing in the end. It is impossible for us to calculate upon conditions which will exist in the future, in this business or in any other ; in other words, live for what is before you and not for what you may expect—that is the whole question of life, and the man who solves this problem best is the man who gets the most out of life.

MR. ALTEN S. MILLER :—I made the statement that I think it is as easy to have the chandelier put in as it is to have this other special form of lamp—the gas arc.

MR. THOMAS D. MILLER :—It is not as easy.

MR. ALEX. C. HUMPHREYS (New York City) :—I did not expect to speak on this subject, and will not express an opinion on the point immediately at issue, but Mr. T. D. Miller made one statement which naturally brings me to my feet. As long as Mr. Miller's statement goes on record I want a statement of mine to go on record to the effect that there is not any difference in *quality* as to the diffusive power between the gas arc and the electric arc. It is a mathematical question, according to the law of the inverse squares, and, in this connection, the sizes of the light sources are involved. Perhaps that is what Mr. Miller meant, but he did not say so. He referred to the relative diffusive *qualities* of the two lights. If we had the two lights, the electric arc and the so-called gas arc, both enclosed in opalescent globes, so that the globe would be the source of light, and they were exactly the same size and exactly of the same candle-power, the diffusion would be the same. It is a mathematical question, and has nothing to do with the quality of the light.

Mr. Alfred E. Forstall (Montclair, N. J.) :—There was another remark made by Mr. T. D. Miller which I do not think he meant in the way in which he put it. He said that you do not want to educate the consumer of to-morrow or next year, but you want to get business now. You might amplify that by saying that you can get business now that will ruin the company next year.

Mr. Thomas D. Miller (New Orleans, La.) :—I do not believe I made any such statement as that. I said the point was to do the business that you can to-day and not try to educate a consumer who would die to-morrow, and you would then have a new man to educate to-morrow.

I take issue with Dr. Humphreys in regard to the statement he makes *if* so and so ; it is not *if*—it is a fact and not a theory that confronts us. The light of an electric arc is emitted from a small point. An opalescent globe is put on the arc, thereby cutting down the quantity of light to sixty per cent. We do not do that—we put on a plain glass globe, so that we get the full benefit of the light—they have to put on an opalescent globe in order to get the diffusion which we already get without cutting down the quantity of our light. The greatest mistake a man can make is to deceive himself. A man is justified in deceiving almost anybody before he deceives himself—be honest with yourself. I say that if the consumer of to-day demands the gas arc, give it to him—because to-morrow someone else will be there and he is going to demand whatever is in vogue at that time. I do not care whether it is in politics or not—I believe the thing that gets there, the thing that counts, is to do what is demanded by the conditions which confront you at present.

Mr. W. C. Morris (Long Island City, N. Y.) :—In all this discussion there seems to have been one point taken for granted, that is, that the public demands the gas arc. It has been my experience, during the short time that I have been in the gas business, that it has not been the public which demands the gas arc at all ; it has been the gas company, unable to supply anything else, that has pushed the gas arc on the public. In the small town from which I come, Long Island City, we have

a few gas arcs out. We have quite a number of saloons in the town, and yet the majority of the saloons are not lighted with gas arcs. Without any urging on our part, the men who seek most for public approval, the bartenders, have lighted their places with individual lights. In a number of cases the ordinary No. 2 Kern burner is used, and they put the lights around the room until the place is one mass of light. We have two wards in our town ; in one ward there is a saloon lighted as just described by me, and in the other there was a saloon lighted with three arc lights, which made ample illumination in three portions of the room. One saloon—the first—is still running, the other was closed up by the precinct boss.

Mr. Thomas D. Miller (New Orleans, La.) :—This reference to the Kern burner reminds me of an experience I had only a few days ago, and I am prompted to tell it. A man came into my office the other day and said, "Mr. Miller, I have had an experience with the Kern burner that I want some one to explain to me. I have a Kern burner in my parlor, and my wife suggested I put a match safe in the parlor near the fixture so that it would be convenient. I did so. I lighted the Kern burner one evening and went over to the wall, raised the lid of the metallic match-safe and dropped it accidentally, and the light went out. I thought this was strange. I lit the burner again, and happened to strike the match-box where it was hanging on the nail and the light went out. That started me to thinking. I took the match-box and dropped the lid, and every time I did so the light went out. I lit the light again, went out in the hall and dropped the lid of the match-safe again and the light went out. The light went out every time I dropped the lid until I got half way out to the gate. There was no other sound I could make, except a metallic sound, that would do it. I could whistle, snap my fingers, make any sound, but it did not affect the light. The minute I struck two metals together the light went out. I want some explanation." I proceeded to give him an explanation. I told him that the long tube of the Kern burner was exactly in tune with the

metallic sound that he gave forth every time he struck the two metals together, and it was based on the principle that they responded exactly to the vibration in the burner—the vibration caused by the two metals coming in contact. I could not offer him anything else, and I gave him the best I had in the shop.

Mr. G. W. Clabaugh (Omaha, Neb.) :—I want to say one more word. Mr. Alten Miller has said it is as easy to put in the chandelier with the open burners as it is to put in the gas arc. I differ with him. We have been trying to put in chandeliers for a number of years before we had the gas arc. We have gotten the gas arc, and we have not been cutting out the chandelier with the separate burners, but have been cutting out the electric arc. That is the fellow we are after. There is no object in our putting in the gas arc where they are burning the incandescent gas burners, the chandelier with the separate burners. There is no object in doing that. If we did I would not consider that we were doing any more business—we would be just swapping dollars ; but it does mean more business when we cut out our competitor's light, and that is what we are doing. We have cut out over 500 electric arcs, and we could not do it without the gas arc.

I speak from experience when I say that the gas arc has done us good. As to its being homely, I am not much of an artist. My wife tells me I buy the biggest pictures, no matter what the subjects may be. That may be the reason I want the gas arc—it is bigger than the other fellows. At the same time our customers are enthusiastic over the gas arc. I went into a place the other day and thought the man was going to give me the store. He said in all his experience he never had such a light. He started in with the Welsbach burners ; took them out and put in the electric arc, and now he has taken out the electric arc and put in the gas arc. He said that if we wanted to refer anyone to him he would take an hour and tell them all about it, that it was the greatest light he ever saw. We imagine a great deal all through our lives. The dyspeptic imagines he has a stomachache nine times out of ten. If we run across a gas consumer who

imagines the gas arc is what he wants, what is the use of trying to persuade him it is not what he wants. Let him have the gas arc—that is the only sensible thing to do.

Mr. Ira F. Wortendyke (Janesville, Wis.) :—One of the great causes of the preference for the gas arc over the single burner is that there is less breakage, and this means less cost for maintenance. The single burners are a constant source of annoyance, more or less, and when you put in the arc you eliminate a large percentage of that annoyance. For the same amount of candle power, actual light, there is much less trouble with the arc lamp. That is one reason why the consumer likes the arc lamp better than the single burner.

Mr. Walton Clark (Philadelphia, Pa.) :—Mr. Glass tells me that in Milwaukee, having built a new office they expended $2,500 for some six-arm chandeliers on which they put Welsbach burners. The lighting was not satisfactory, so they took out the chandeliers and put in gas arcs with four burners, and the office is much better lighted, much more attractive and the lighting effect is very much more handsome. That is a strange experience in view of Mr. Miller's experience in his office. I admit and assert that Mr. Miller is right in his statement that the perfect lighting is from a large number of small sources of illumination. That must be so, but the public demand a gas arc. They do demand it. There is no doubt about that. They want it, and if they cannot get it they will take the electric arc. It seems to me the business of the gas companies is to supply the gas arc. If there are some other forms of lighting which are better or cheaper, other forms of lighting by gas, it is the duty of the gas company to try to educate the consumer to use the better system, but not educate the consumer away from gas, and certainly not to refuse him the gas arc if he wants that.

Mr. Alex. C. Humphreys (New York City) :—In regard to the commercial aspect of the subject, I will say that I agree with the gentlemen on both sides. But when it is claimed that one source of light has a superior diffusive quality when compared to another, I object. If you compare four incandescent gas burners grouped in a globe one foot in diameter

with four similar lights grouped on a chandelier so as to be spaced on a circle four feet in diameter, the light will be more evenly diffused by the latter arrangement. The diffusive quality of the light will not be altered—it is simply a mathematical question.

Coming to the commercial side of the subject, I think that Mr. Clabaugh's argument cannot be answered. If the people definitely want the light as a so-called gas arc, give it to them in that shape. If, on the other hand, we can educate them in this connection or in any other connection to a point where they can get more light for the same expenditure, it is our duty to do that. If, however, we can sell them gas arc lamps, and cannot sell them any other form of lamp, let us sell them the arc lamps. The personal preferences of our customers must be reckoned with and catered to.

Mr. John H. Keppelman (Reading, Pa.):—We happen to have two offices, separated by a corridor, and these offices are exactly the same size. We light one of these offices by means of chandeliers and individual Welsbach lights. In the other office we have three gas arc lights. The one lighted with the chandeliers is very much better lighted than the other; but notwithstanding this, we sell many more arc lamps than individual incandescent lamps.

The Chairman:—We apparently shall not be able to determine this discussion satisfactorily, and we do not want to get into a hopeless controversy.

Mr. Miller resumed the chair.

The President:—We will now receive the paper by Mr. Henry L. Doherty on Municipal Ownership.

(For paper see Appendix, page xli.)

The President:—Gentlemen, you have listened to an unusually interesting paper, and it is now before you for discussion. Is anyone prepared to make any remarks on this subject, which interests us all very deeply? Is it possible you all agree with Mr. Doherty in everything he said? We had one discussion pretty well started this afternoon, and I hoped we would be able to keep it up.

THE SECRETARY:—When we planned this paper, we also planned to get a discussion on it by persons outside of the gas business who were familiar with the economic principles underlying municipal ownership. We selected a number of men on each side of the question for this purpose. It was thought we would have the paper printed ready for distribution early in September. Unfortunately, Mr. Doherty's business engagements prevented him writing it as soon as he expected, and I did not get it printed in time to send out so that we could get written discussions from the men who could not attend the meeting. I did, however, send a copy to Prof. James Mavor, of the University of Toronto, who has been making a study of municipal ownership of public service corporations, the city of Toronto having to a certain extent the municipal bee in its bonnet at this time. I have received from Prof. Mavor a communication which I will now read:

COMMUNICATION FROM PROF. JAMES MAVOR.

What seems to me a desirable end to aim at with regard to public utilities is well-defined public control by federal government, state or municipality, preferably by the more powerful and impartial authority. This control should be sufficient to prevent injurious exploitation of the public by the corporations on the one hand, and sufficient to prevent injurious exploitation of the corporations by the public on the other hand. The exercise of this control with certainty and regularity would prevent spasmodic interference with the corporations holding public franchises, and at the same time would compel them to live up to their contracts under the guarantee that if they did so their interests would be respected. Uncertainty of tenure has always led to inadequacy and to high cost of service. Restrictions, perhaps honestly imposed in the assumed public interest, have often turned out to be disastrous both to the corporations and to the public.

When municipal ownership of the streets has been duly safeguarded in the common interest, it seems to me that the cheapest and most effective service in the public utilities almost without exception can be obtained by leasing the right

to perform these to spontaneously organized corporations, and then to allow these corporations the utmost freedom in the management of their business. No corporation can for any great length of time continue to render inadequate service at an exorbitant cost.

The so-called monopolistic character of the public utilities has been greatly exaggerated. The progress of modern invention must speedily alter current views in this connection. There is no monopoly in light for example—oil, gas and electricity are already violent competitors, and it may be that the recent discoveries in radiation will completely upset the present conditions both of public and private lighting. Surface railways, elevated railways and subways compete in civic transportation, as electric and steam lines compete in inter urban transportation. The substitution of new methods has destroyed, or may destroy, any of the so-called monopolies.

The safety of public, franchise-holding corporations must therefore lie in efficiency of service and in constant alertness in satisfying new customers, rather than in formal observance of inflexible regulations.

It is clear, moreover, that the terms of the lease must be such as will enable the service to be rendered at the lowest cost to the community, and this desirable end cannot be attained unless the company to whom the lease is granted is at any rate not prevented from securing the service at the lowest cost in respect of interest and other charges. If the tenure is uncertain, the terms of the lease inexact, or the conditions irritating, the service cannot be cheap. The cost of litigation, for example, howsoever entailed, must in one form or another be borne by the public.

Compulsory co-operation, which is involved in municipal ownership and operation, appears to be less advantageous upon many grounds than spontaneous co-operation. Even with an absolutely honest municipal government, the granting of leases on such terms as will enable the grantees to obtain their capital at the lowest rate and to conduct their business in the most economical way must be more flexible, more likely to be progressive in technical methods, and more likely to be cheap than the operation of these services by municipal func-

tionaries, who are often appointed not because of their technical ability, but because of the political influence which they are able to command.

THE PRESIDENT:—We shall be glad to have further discussion on this subject.

MR. ALFRED E. FORSTALL (Montclair, N. J.):—I did not expect to say anything on this question, but what Prof. Mavor has written in his first paragraph is exactly my idea on the subject, and I want to amplify his text a little. It strikes me that in all this discussion of municipal ownership, the point of view seems to have been that there are only two ways by which these public services can be rendered, that is, either by corporations unrestrained by any public control and subject to a great number of evils, as alleged by the municipal ownership advocates, or by the municipality. It seems to me that this is not at all the case. If the evils exist, many of them will not be cured by municipal ownership. The political evils, for example, the evils of political corruption, would not be a bit better under municipal ownership. I do not think the conditions under municipal ownership in that respect would be any better than the worst possible (with similar conditions of municipal government) under private ownership, not regulated by some central authority. To do away with the possibility of political corruption it is necessary to do as Prof. Mavor suggests, put the corporation, whether a private corporation or a municipal corporation, under some central control; and there is no question in my mind that a great deal better results can be obtained in the performance of a public service, from a properly controlled private corporation, than can be obtained from any municipal corporation, using the term "public service" in the sense in which it is usually used and applied to transportation, gas and electric light companies and things of that kind.

As Prof. Mavor says he may in two or three weeks send us a more complete discussion I move that in case he does so, the Secretary be given authority to publish such discussion in the Proceedings of this meeting, after consultation with the other officers of the Association.

(Carried.)

THE PRESIDENT:—Is there any further discussion?

MR. WALTON CLARK (Philadelphia, Pa.):—I had the pleasure of reading the proof of Mr. Doherty's paper, and made a few notes on one or two scattered ideas in connection with it.

I have, with great interest, read Mr. Doherty's paper, and listened to the discussion which has followed. I am especially pleased with Mr. Doherty's statement of the arguments advanced by the advocates of municipal ownership and with his answers thereto. These, I think, should be read with care by every man who is concerned with the operation of a gas plant and the protection of a gas company's interests, and by every man who is concerned with municipal government, and who, therefore, is, or should be, a protector of the interests of the citizen.

My experience justifies my endorsing Mr. Doherty's statement that the threat of municipal ownership has a deterrent effect upon investment. It needs no argument to prove that capital will not seek investment where it is likely to come in competition with a municipally owned plant, or where it is likely to find itself without a franchise, or compelled to sell at an appraised structural valuation, because the citizens of the town in which it is invested have a hankering to experiment with the ownership of a railway or of a gas plant.

I do not think we need to prove that socialism is either impossible or inequitable in order to demonstrate the unwisdom of a city undertaking the ownership and operation of a gas plant.

There is little that I can say that I have not said to you before upon this subject, or that is not contained in Mr. Doherty's paper. I believe that the operation of industries is not an essential or a natural part of the function of a municipal government. I believe that the burden of proof is on any government desiring to enter on any enterprise not essential to the exercise of the police power and the protection of life, health and property. That the operation of a street railway or an electric light or gas plant is essential to this protection, is not susceptible of proof. Personally, I am very

much concerned as to the condition of the pavement in front of my neighbor's house, because I must walk over it, or drive over it, if I would leave my own premises—all the material that is brought to my premises is hauled over it and I am a loser if the pavement is not in good order. I am very much concerned with the question of the condition in which my neighbor keeps his back yard, because if his premises are in an unsanitary condition I or my children may contract disease. I care not at all, except as I may be a stockholder in some interested corporation, whether he lights his house with gas, electricity or candles, or whether he sits in darkness. I do not care whether my neighbor walks, drives, rides in a trolley car, or stays at home. Therefore, the protection of my rights does not require that the city interest itself in providing means for lighting buildings or for carrying the public in the city in which I dwell. And I maintain that a government's exclusive function is the protection of the governed in their rights, except that a government may appropriately undertake such work as is to the unquestioned interest of the whole people and without expectation of direct financial profit to the government. There are few such opportunities. The paving and draining of the city and fighting of disease are instances. The deepening of harbors and carrying of mails may be others.

I think Mr. Doherty has been wise to limit his discussion of this subject to the theories involved. To quote figures involves introducing questions and details from which we cannot thresh the truth in the few hours we may devote to the subject at this meeting. I believe him to have established that the municipal ownership and operation of industries is wrong in theory, and with that I am, at this time, content. I have had opportunities for learning the results of the operation of municipal plants, and from them I learn again that what is wrong in theory cannot succeed in practice. I have visited a number of municipally controlled plants and heard the arguments of the advocates of municipal ownership, based largely on the operation of these plants. I have found their statements frequently not to accord with the vital facts, and I have recorded some of these differences in the Proceedings of

this Association. I do not believe that the arguments we have made or are making, or any arguments that we may make, will have effect on the at present pronounced advocates of municipal ownership. I do believe, however, that properly presented to the thoughtful and uncommitted citizen they will go far to prevent his being misled by the arguments advanced by the advocates of municipal ownership. I recommend to each of you that you be always prepared to so present them. I believe it to be your duty to your employer and to your government.

MR. G. W. CLABAUGH (Omaha, Neb.) :—I have listened to Mr. Doherty's paper with a good deal of interest, because I was very skeptical as to the wisdom of having such a paper, when I heard he was to write a paper on this subject to present to this meeting. I thought it was a good plan to let the sleeping dog lie. I do not think Mr. Doherty has awakened him. I think he has only turned him over so that he will have more pleasant dreams. In my opinion he has handled this question so fairly to the municipal ownership advocate, as Mr. Clark says, that it will not only do the corporation men good, but it will do the other fellows just as much good. I believe that if this paper was sent to the mayor of every city in this country it would have a wonderful effect, because this municipal ownership idea is a political question. As a rule, in most cities it has to go before the council and the mayor before bonds are voted for by the people, and we can expect more from his honor, the mayor, than from any other man in politics in the various cities. I believe that if we can spread a paper of this kind, which is so fair, broadcast over the country—and it seems to me the argument is so fair—that it will do a great deal in stemming the tide in favor of municipal ownership, and I say again that I am glad to know that I could be converted, for the reason that I am a little stubborn in my ideas sometimes and I am like the gentleman from Missouri—I have to be shown. Mr. Doherty has shown me.

MR. ROBERT M. SEARLE Mt. Vernon, N. Y.) :—I want to emphasize what Mr. Clabaugh said, speaking of the benefit of papers of this kind. We have recently passed through four

spasms of municipal ownership, and each time we have killed it. We have a Vice-President who has been hard at work and taken up every feature of this municipal ownership question and brought it to the notice of the citizens, when there was a call for a vote on the municipal ownership proposition at the polls. The more papers we have, showing the weakness of the movement, the easier it is for us to head off municipal ownership, and a paper of that kind distributed to the people in an intelligent manner will do more in a minute than the argument of the gas or electric light company's representatives could do in a week.

Mr. Donald McDonald (Louisville, Ky.) :—One of the speakers said this afternoon that we might sometimes be justified in deceiving others, but never justified in deceiving ourselves. I agree with him thoroughly. A public utility corporation does not stand exactly where a grocery store stands. If one grocer does not treat you right you can go to another, but if a public utility chooses to charge an excessive price, you have no choice but to pay it. What I am going to say does not apply so much to gas companies. Oil and other illuminants compelled the gas companies years ago to cut down the prices on their products. They were compelled to give to the public the public's share of the cheapened cost of producing light, and if there were no other corporations interested in public utilities except the gas companies, there would be no agitation for public ownership. The cost of gas has already been cut down as the cost of producing it diminished. But if you will talk to anyone in regard to the matter of transportation he will say, "I am paying as much to ride on street cars now as when mules were employed to pull the cars," and you cannot answer that argument. What the people want is not so much municipal ownership, as relief from a monopoly which holds out no hope of improvement. When electricity came in and supplanted mules, the cost of hauling passengers was very much reduced, but what was the result? The capital of the companies was expanded to take up the difference. There are ways of reaching that sort of thing much better than municipal ownership. In many cities

in England there are laws allowing the gas companies to pay a certain dividend so long as they sell gas at a certain price and an increased dividend whenever they can lower that price. A partnership of that sort existing between a city and a private corporation gives the people what they are entitled to —that is, their share in the improvements made by advancing science. At the same time it makes the securities of the company safe investments. But to say that municipal ownership is all wrong, and to hold out to the people no hope whatever that at any time in the future will they get articles of absolute necessity any cheaper than they are getting them now, is taking a position from which, if we do not recede, we will be driven.

Mr. Walton Clark (Philadelphia, Pa.) :—I do not know of any corporations that are in the attitude Mr. McDonald speaks of. He certainly is wrong in his facts in reference to the street railways. He says the public has received no benefit. In many places the public does not pay as much for street car transportation, and in many other places they get more service for the money they do pay. Time is money. In New Orleans they may pay as much as in the old mule days; but you can go now from Canal Street to Carrollton in twenty minutes less than it required in the old mule days. You save that amount of time. If you ride at night you have a brilliantly lighted car, and a car which runs more easily. The ample light makes the car a pleasant place to sit in, and you are able to read. You save that amount of time if you are a reader. The citizens of New Orleans have benefitted very greatly from the introduction of the trolleys. In Philadelphia the fares have been reduced, and this is true in many other cities in the country. The trolley has done more for the riding public than it has done for the owners of the street railways, and that is the history of every improvement in every public industry—electric light, gas, street railways, and other things in which the public is interested. The public gets a greater advantage from all improvements that are made than do the companies.

The President :—Gentlemen, are there any further remarks?

Mr. Thomas D. Miller (New Orleans, La.):—A point in connection with this municipal ownership question struck me as being one which has never been brought out properly. Every quasi-municipal corporation in possession of a franchise must, as a matter of self-preservation, look to the future with the possibility of having a fight on its hands to preserve its corporate existence, and especially to ward off the evils which follow from illegitimate competition. As a consequence, it must provide for that possible period in the future when it may have a fight on its hands; a certain amount of money which may be sunk and absolutely lost in making a fight against a competitive company. It has occurred to me repeatedly that a solution of this question would be in an absolute monopoly, granted to an electric light or gas company, or any other kind of public service company, in which the corporation—I mean the city—would grant to the gas company or the electric light company absolute immunity from competition, and thereby make it absolutely unnecessary for them to provide for future contingencies in the shape of a competitive company. That phase of the municipal ownership problem has occurred to me many times, and in my work I have presented that argument as one reason why the private corporation could not possibly furnish light as cheaply as if it were granted the immunity it was entitled to, coupled with proper regulation based on a certain amount of return or interest on its investment. That is one of the first thoughts which suggested itself to me upon reading Mr. Doherty's paper. Mr. Doherty says, take away the continual threat of competition. That is the very point that I would make, that the taking away of the threat of competition would make it possible for a private corporation to operate its plant at a much lower profit on the investment.

The general consideration of what gives its value to a corporation is a question which the public in its craze, you may say, for municipal ownership has lost sight of, and I am particularly pleased to see the point brought out so prominently that a corporation makes it possible for the man with small capital to become a participant in the investments of these public service corporations. That is absolutely the secret of

the supremacy of the American people to-day, the fact that such possibilities and opportunities have been offered to the American people. The rich man's dollar could be made to realize ten or fifteen per cent. profit, while the dollar of the poor man could be made to earn but one or two per cent.; but the opportunity for several or many men to combine their capital makes the poor man's dollar worth just as much as the rich man's dollar. It is the old Darwinian theory of the survival of the fittest, and it is the American public service corporation, as well as the private business corporations of the country, which has made it possible for the American people to exercise that principle in political economy and in the financial world—that the poor man's dollar shall be worth as much as the rich man's dollar—giving the poor man a chance to survive with the rich man. I find this point here marked ; "It remains only for the organizers of incorporated companies to issue securities in such small amounts as to be available for sums of money not larger than fair-sized individual savings banks deposits." Now, it may be that the public corporations, quasi-public corporations of this country, are more or less responsible for this craze for municipal ownership, in that there have been glaring instances of over-capitalization, in which the quasi-public corporation has tried to make more out of the ownership in the shape of over-capitalization ; and, as I said before, and as my friend Mr. McDonald quoted, that we are justified in deceiving anyone before we do ourselves—that introspection is a good thing for the man who has the courage of his own convictions and a poor thing for a timid man. Let us look into the matter to see if there is any fault attaching to ourselves in this light, and I believe we will find that such is the case. I do not mean that we shall only apply these things to the other fellow, but we must apply them to ourselves.

Just as a passing remark, I do not exactly know what Mr. Doherty means when he says that capitalists are largely the sons of ministers, farmers and mechanics. I never heard of any son of a minister having become a capitalist. He is a good fellow usually.

In connection with the question, "Is there any good reason

for municipal ownership?'' Mr. Doherty says: ''The scheme finds considerable advocacy, and if there is any reason why a city should embark upon a business enterprise, this reason should not be in discord with wisdom. There also should be a satisfactory reason for selecting this particular class of business enterprise upon which to embark.''

I made a note in connection with that ''Jeffersonian Democracy,'' and my recollection of the thought in my mind at the time when I made the note was that the idea involved in Jeffersonian Democracy—that is, the thing which is uppermost at this time upon the anniversary of the Louisiana purchase, concerning which I made a remark or two this morning—was that government should devote itself entirely to legitimate lines, and not enter into private enterprises which legitimately belonged to the individual, or an aggregation of individuals represented by a corporation. In my opinion, monopolies are entirely proper when they are under proper regulation and control. A monopoly is to the advantage of the people if that monopoly serves the people in the best possible way. I mean by that that a monopoly can serve better than a competitive concern, because it does not have to provide against competition. One of the arguments advanced by those in favor of municipal ownership, as I understand from Mr. Doherty's paper, is that municipal ownership will break up monopolies.

An unfortunate number, ''thirteen,'' precedes one of the reasons for municipal ownership—''to protect municipal officers from temptation.'' I remember an old saying that ''virtue is its own reward,'' and I do not see why it should not apply to a municipal officer the same as to anyone else. I am one of those idealists who do not believe it is necessary for municipal corporations to go into private enterprises in order to make their officials honest, and I do not believe it would do it anyhow.

There is one reference in the paper to the subject of the taxpayer voting on the question of municipal ownership. I happen to be thoroughly and intimately acquainted with the method by which a certain bill or law was passed for the municipal ownership of one of the most gigantic failures this country has ever seen in the history of municipal ownership—

I refer to Austin, Texas. Private information that I have shows that for about a year prior to the vote on the building of the dam that fell away—I mean the dam at Austin, Tex.—every man who had so much as a watch that could be taxed was importuned to go up to the assessor's office and declare it for assessment, so he could vote on the question whether the city of Austin should build a dam and dam the Colorado—and it has been damning it ever since. The result of the vote was quite a majority in favor of the city of Austin building this dam, and the corollary of it was that the man who was burning the light, using the electricity, was not the man who was paying the taxes. The Mayor of Austin, after a year or more of operation of the electric light plant, issued a circular to the voters and taxpayers of Austin, asking them why they should patronize an enterprise that was a private enterprise, as opposed to an institution in which they were stockholders, and he said: "If you do not patronize the municipal plant, you will have to pay taxes to make up the deficit." There you have the secret of most of the municipal plants.

THE PRESIDENT:—We should be glad to have Mr. Doherty close the discussion.

MR. HENRY L. DOHERTY (New York City):—The arguments I have presented to you on this question of municipal ownership are not all the arguments I could think of, but I thought they were sufficient and I did not want to tire you out. Taking the best of the arguments at hand against municipal ownership—the number which I at first thought it advisable to use—would make this paper fifty per cent. longer. I simply chose a part of them, and the balance were cut out.

There are many arguments against municipal ownership. One of the chief arguments against it in my opinion is, "Does municipal ownership provide a proper division of the benefits of municipal operations?" admitting that some benefits do exist—that is admitted by us for the sake of argument, but we cannot admit that these benefits really do exist, if we have been observers of the results obtained by the operation of municipal plants.

The question of municipal ownership is one which apparently will not down. The men who continually bring municipal ownership to the front are going to continue to bring it to the front, whether they are convinced that it is inequitable, inexpedient and irrational, or not. They are bringing it to the front for a certain purpose, and it seems to me that it would be desirable to rid ourselves of this constant threat of competition or confiscation, even though we may feel that our property is not seriously menaced by that threat; we may feel that our property is no longer seriously menaced, as we thought it was a few years ago, but men who have capital and whose capital we should like to incorporate in our businesses may be more apprehensive of the effect of these threats than we are, and, therefore, I think we should try to dispose of this question of municipal ownership.

Mr. Clabaugh took the position which I took at the start, when this question of municipal ownership was first suggested, and that is, that it may not be a good thing to agitate the question, and we certainly ought not to agitate it unless the agitation would leave us in a better position than we were in before. The friends of municipal ownership are going to agitate the question whether we do or not; and we must have something more effective than talk to answer the advocates of municipal ownership.

The National Electric Light Association has taken the most aggressive stand on this question, and I think the American Gas Light Association could afford to take some action which would not only pledge their moral, but, if necessary, their financial, support to demonstrate the true condition of municipal ownership as it now exists.

Mr. T. D. Miller referred to one point in my paper regarding men of affairs, and he said that he did not know that ministers' sons became men of affairs. I had a particular man in mind when I wrote that part of the paper, but would not care to use his name. However, I will say that I believe Mr. J. Pierpont Morgan is a son of a minister.

THE PRESIDENT:—Mr. Doherty, we are obliged to you for presenting such an admirable paper on the subject of municipal ownership, in which we have all been much interested.

Gentlemen, the time is getting short. I have a letter here from the Chairman of the Committee on Electrolysis, stating that the committee has been unable to prepare a report for this meeting. If there is no objection the committee will be continued.

I have here a question: "Should not gas companies make a minimum charge of one dollar per month for service?" A reply to this question has been received, but we will not be able to consider it now. It is a very important question, and I should like those members who have replies to make to it to send them to the Secretary, and if there is no objection we will have them published in the Proceedings.*

Mr. Robert Young (Pittsburg, Pa.) :—I move that the thanks of this Association be tendered to the President and the Committee of Arrangements for all they have done to make this a successful meeting.

The President :—You have heard the motion, gentlemen. It is not very becoming in me to put it, but time is getting very short.

Mr. G. W. Clabaugh (Omaha, Neb.) :—I amend the motion that the vote be a rising vote.

Mr. Robert Young :—I accept the amendment.

Vice-President Norris put the question and the motion was unanimously carried by a rising vote.

The President :—Gentlemen, I thank you very much for your vote; and I thank you more than I can say for the compliment which you paid me in electing me President of this Association.

I have tried to do what I could to make this meeting a success, and to make the Association stronger and better for my having been its President during the past year. I realize there have been many things left undone which should have

* The reply sent in to this question was withdrawn by its author, so the way is clear for a thorough discussion of the subject at the next meeting.

been done, but I hope you will go away with pleasant recollections of this meeting.

Mr. W. C. Morris (Long Island City, N. Y.) :—I move that we now take a recess until to-morrow afternoon upon returning from the excursion, and that final adjournment be taken at that time.

This motion was carried and final adjournment was taken in accordance with it.

THE PROCEEDINGS

OF THE

American Gas Light Association.

Thirty-First Annual Meeting.

1903.

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OUR CORRESPONDENCE SCHOOL.

Written for the Thirty-first Annual Meeting of the American Gas Light Association by Alex. C. Humphreys, New York, N. Y.

This is a most fitting time to review the work of our Association's Correspondence School, for the period covered by the subscriptions obtained in 1898 has just expired, and those who have been supporting the undertaking should be given every opportunity to learn by the results so far obtained whether they are justified in continuing that support.

It was therefore suggested that I should supplement the official report of the Trustees, prepared for this meeting, by this paper in the hope that these two presentations of the subject, together with the discussion which should thereby be developed, would serve to place the facts in regard to this important undertaking fairly before the old subscribers, the members of the Association and all others interested in the prosperity of the gas industry.

Many old subscriptions have already been renewed, and, in view of the evidence now available, it is hoped that not only will the remaining old subscriptions be renewed, but that some of them will be increased and that many new subscriptions will be made.

In February, 1899, I presented a paper to the New England Association of Gas Engineers under the title "Correspondence Schools," in which I presented the facts in regard to this Association's Correspondence School; and I have also from time to time presented papers on educational subjects to this and other gas associations.

In what I now have to say I shall to a great extent repeat myself. There are two chief reasons why I shall not hesitate to do so:

First, because since writing the paper first referred to the work of our Correspondence School has been on further trial

for four and a half years, and thus the opportunity is now afforded to test the correctness of such of my statements as were based upon estimates and opinions ; and, second, because my observations in the past were made almost entirely from the view-point of the man outside of the regular institutions of learning, and so most of my impressions had been received from the study of results in our industry achieved by workers who had gained their technical training through various educational processes ; whereas now I am able to speak from the additional experience gained as the head of a school of engineering of the first rank. This last experience, while short in time, has been concentrated and instructive.

It is therefore a pertinent inquiry, Has this later experience brought about any considerable change in my views on this most important subject ?

In my New England Association paper I unreservedly endorsed the work then being done by the Trustees of the Gas Educational Fund. The work done by the Trustees and the additional experience I have since gained in the line of technical education, both justify me in again strongly recommending this scheme as one of efficient philanthropy and as one which, from a selfish standpoint, we can profitably support.

In 1895 this Association authorized a committee to establish in its name a Correspondence School of Gas Engineering.

Although I do not wish to be ungracious, it is pertinent to my present purpose to remind you that a large percentage of our membership then regarded this undertaking as chimerical or worse, and therefore were not willing to support it, but were only willing to withhold their active opposition. By a few the scheme was actively opposed.

The committee, with the full courage of its convictions, organized and carried on the work until 1898 without pecuniary assistance.

The work of instruction was performed by Walton Clark, a notable example of self-denying devotion to a sense of duty, loaded down as he was with the burdens and responsibilities of his official position.

The results so obtained by this committee were, in the opinions of its members, of such a character as fully to warrant

the continuing of the work by means of a more complete and permanent organization and under the charge of a salaried executive.

Those chiefly interested in the movement canvassed for subscriptions among those pecuniarily concerned in the gas business, for it was not to be expected that this Association as such could assume a large part of the pecuniary burden. Subscriptions in a sufficient amount to carry on the work for five years were finally obtained, and, with the co-operation of this Association, a permanent and independent Board of Trustees was organized to administer the funds subscribed and to direct the work of instruction.

In canvassing for subscriptions there was met some hearty encouragement, much indifference and considerable opposition.

But in spite of lukewarmness and active opposition a sufficient—though barely sufficient—fund was subscribed, and the scheme was insured a pecuniary support for five years.

It should be particularly noted that a considerable portion of this support came from the manufacturers of gas apparatus, appliances and supplies. All honor, therefore, to our associate members!

So our Correspondence School work was more completely and permanently organized.

A. E. Forstall, the Secretary of this Association, was appointed Secretary, Executive Officer and Instructor.

As is generally known, Mr. Forstall is peculiarly well qualified for this work. A graduate of the Engineering Department of the Lehigh University, he has the additional practical experience gained during years spent in the management of gas works under his father, the late Theobald Forstall.

Alfred Forstall's work as the executive head of our Correspondence School has again proved him to be, both in head and in heart, a worthy son of his great and good father.

The conservatism of the business management of the Trustees is shown by the fact that although there have been repeated demands made upon the Board to increase its expenditures, each year the expenses have been kept below the income applicable to that year, and the surplus so reserved has

been carried into a special fund as the nucleus of a permanent endowment. This fund now amounts to more than $3,000. This should encourage more and larger subscriptions, for subscribers can rest assured that in every case surplus income will go to swell this fund and so further insure the permanency of this undertaking.

The report of the Trustees presented at this meeting has given you detailed information as to the numbers of those under instruction and the like. I shall not burden you with a repetition of these data, but I wish to impress upon you the fact that a considerable number of our students have already been enabled through our instruction to take higher positions in our business, and that a further considerable number are now being helped to a greater efficiency as employees and wage-earners.

Let me recommend to you a careful reading of the circular letter and accompanying papers issued to our subscribers under date of May 21st, this year. These papers set forth the value of the work done and furnish to the subscribers sufficient reason for renewing their subscriptions. There is one figure which can be established from that circular to which I wish to direct your attention, namely, the average yearly cost of instruction for each student. The criticism has been made that this cost is so high as to show that the scheme of instruction is inefficient in operation. If we take the total cost per annum as $4,000, and the total average number of students as 100, we have a yearly per capita cost of $40.

At Stevens Institute of Technology the minimum yearly tuition charge is $150 (considerably less than at some other of our engineering schools), and from the endowment there is supplied an additional $100 per annum ; that is, the full cost of tuition for each student is about $250 per annum. The additional cost to each student for books and materials is about $50 per annum, making a total of say $300, or 7½ times the total cost per capita in the Association's Correspondence School.

Moreover, the students of our Correspondence School have the additional pecuniary advantage that they can continue and improve as wage-earners while pursuing their studies.

I quite appreciate that the two schemes of education so widely differ that a fair comparison cannot be thus made, but as the criticisms I have referred to were made in connection with such a comparison, what I have here shown will at least serve to meet those criticisms.

No doubt the cost per capita in our Correspondence School is much in excess of the cost per capita in the large correspondence schools. In the latter, education is carried on wholesale and the plant and equipment do not have to be increased in proportion to the increase in enrollment of pupils, and so the cost per capita is low by reason of the thousands of students enrolled.

But surely we may believe that in the teaching of *our specialty* we are able to do for our students more than could be done for them by any of those mammoth correspondence schools. The very fact that our number is so limited is all-important. Though our instructor does not come in personal contact with the instructed, each case is individually considered and treated, and just as much in the way of personal teaching is accomplished as is possible through correspondence methods. To obtain anything approaching a high degree of efficiency in teaching, there must be individual teaching. I am inclined to think that, if we are to maintain our present efficiency, we have gone almost as far as we can go with a single instructor. A considerable addition to our classes would require at least one additional instructor, who should be specially qualified, technically and practically. As the salary of our instructor is by far the largest item of cost under our scheme, the minimum cost per unit has been nearly reached.

It cannot be fairly claimed that a technical education as complete as that obtainable in our best technical schools can be obtained through any correspondence school. On the other hand, it is a fact that the students of a correspondence school, as far as they go, have fuller opportunity than do the college students to carry along together the theoretical studies and the practical application of those studies.

The students of our Correspondence School possess this advantage to the fullest possible degree, for they are working

in the particular business to proficiency in which their studies are directed.

A most important advantage is possessed by the student who day by day is practically impressed with the necessity for the knowledge for which he is striving, and then in daily practice has the opportunity to apply that knowledge.

I am inclined to believe that on the average our schools of technology could do nearly as much with their students in three years as they now do in four years, if every freshman as he entered college could be passed through a process which would instantly create in him a keen appreciation of the value of all the subjects included in the curriculum. Instead of this it remains for many of them to learn after graduation why certain studies were made a requirement for their graduation. Without such an appreciation at the time of study it is impossible for students to get anything like a full value from their course of study.

Here is to be found the reason why certain students, who go to college late in life, having already acquired certain practical experience but generally with their ability to readily acquire book knowledge more or less diminished, still succeed in getting more out of their course of instruction than do the youths fresh from the preparatory schools. The older students have learned by experience the value of that which the college offers. They have already experienced the need for this knowledge and they are therefore more ready to appreciate to the full the practical applications of the mathematics, physics and chemistry, not to speak of the non-technical branches, which they are required to study.

This is the advantage possessed to an eminent degree by the students in our Correspondence School, and still further than even the older students in the technical colleges, for our students do not have to depend in this regard upon past experiences only, but their appreciation of the value of their technical studies is continually renewed and developed by their daily work.

From a survey of all the questions placed before the students of our Correspondence School during the whole course, it may be thought that but little ground is covered. But there

is more to influence the students than appears on the surface. To completely answer the set questions, the students must do a large amount of preparatory study, and in this work they are encouraged and intelligently directed. In studying to answer the set questions, the students will learn much more by the way, and *they will learn how to study and to think for themselves.*

While, therefore, membership in this school is to a large extent valuable because it incites the students to and directs them in systematic study, that it has in my opinion also a more definite and specific value can be seen from the fact that I advise college graduates who wish to engage in the gas business to subscribe for the questions and answers and so obtain the more closely specialized training which is necessary in every case in addition to the more general and fundamental technical training supplied by the colleges.

The graduate of a good technical school has a great advantage over the man who has only a practical training, *provided* the technical graduate is willing to acknowledge the value of the other man's practical training, and, acting on that knowledge, to supplement his college training by completely mastering the practical applications of theory, and the technical and commercial requirements of the particular specialty in which he is employed. This he should be able to do the more quickly and completely because of his college training.

But first he must recognize the necessity for and be willing to undertake the drudgery to acquire this knowledge which the colleges fail wholly or in part to supply. Here too many technical graduates fail; and so technical training is discredited in the persons of some of its professed exponents.

The students of our Correspondence School, by reason of the conditions under which they work, are but little exposed to this danger.

There are many questions raised to-day as to the ultimate value of much of our professional training, and some of these questions are worthy of thoughtful consideration. I doubt the wisdom of turning out as many lawyers and doctors as we are yearly graduating from our colleges and universities. The supply threatens to exceed the demand, if it has not already

done so. Possibly in the not distant future the same question may be raised with regard to the product of schools of engineering; though here it is to be considered that the training given in those schools is applicable not only to one line of work, but is applicable to the whole wide range of industrial effort.

But, whatever questions are raised in this direction, there cannot be any question as to the wisdom *of assisting men who are already engaged in the gas business* to fit themselves to more perfectly perform the work entrusted to them and to take higher positions in that business.

Those of us who are pecuniarily interested in the gas business can well afford to support this Association's Correspondence School, if only from selfish motives. But I do not hesitate before the members of this Association, so many of whom I know so well, to appeal to higher motives.

When the day comes, as it will come to every one of us, to review the years spent here on earth, regret upon regret must be experienced for our failures to accept the opportunities offered to us to help our fellowmen. We shall regret our failures to accept such opportunities even when to have done so would have required of us distinct self-denial. What shall we feel, then, in such cases as the present, where this help can be given at the cost of little or no self-denial?

I hope and believe that the subscriptions now expiring will be more than renewed, and that the Trustees will thus be enabled to carry on and extend their work for another five years, and that finally an endowment of $100,000 will be secured, thus insuring the permanency of the undertaking. If such a result should be secured, the American Gas Light Association would occupy a proud position among the world's associations of engineers.

THE POLICY OF

GAS ENRICHMENT.

(Illustrated by London Practice.)

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THE POLICY OF
GAS ENRICHMENT.

(Illustrated by London Practice.)

WRITTEN FOR THE THIRTY-FIRST ANNUAL MEETING OF THE AMERICAN GAS LIGHT ASSOCIATION BY ARTHUR GRAHAM GLASGOW, LONDON, ENGLAND.

PREFATORY NOTE.—The author has added the above bracketed phrase to his title, because he believes that greater interest will attach to this statement if the general consideration of the subject be supplemented by specific figures showing the value *versus* the cost of enhanced quality, and the present London situation offers opportune facilities for such specific comparison.

The three London Gas Companies (each of which has a separate and distinct district) were formerly required to supply gas giving the luminosity of 16 standard candles, when burned in the "London" Argand at the rate of 5 cubic feet per hour.

In 1900 the South Metropolitan Gas Company sought and obtained Parliamentary sanction to supply gas of 14 candle-power (when reduced to 5 cubic feet hourly), tested at 16 candles luminosity, *i. e.*, when burning at the rate of 5.7 + cubic feet per hour.

The Commercial Gas Company obtained similar rights in 1902–3, leaving the Gas Light & Coke Company (supplying about 60 per cent. of the London consumption) as the sole Metropolitan purveyor of 16 candle-power gas.

The witnesses employed by the South Metropolitan and Commercial Gas Companies, in support of their 14 candle-power standard, so decried the value and proclaimed the evil of the additional two candles luminosity, that the London County Council (originally opposed to the reduction in quality) promoted an amendment in the Session of 1903 to compel the Gas Light & Coke Company, *inter alia*, to adopt a 14 candle-power standard, with a compulsory reduction of twopence per 1000 cubic feet in the price of gas. Unfortunately, this amendment was withdrawn, owing to concessions by the Company in other directions, and the opportunity of ventilating this question in Parliament was lost.

The South Metropolitan Gas Company and its allied Commercial and Crystal Palace Companies have formulated a Parliamentary case for low-grade gas with zeal and even with vehemence, but no gas undertaking has yet been required to traverse their arguments and establish the case for enrichment. For that reason the author is encouraged to offer this small contribution to the common knowledge.

As destruction is easier than construction, so it would be, perhaps, easier to destroy the fabric of evidence erected in support of the reduced standard than

to specifically measure the advantage of supplying the higher quality of gas; nevertheless, the latter task appears to present so little difficulty that it is attempted within the limit of this communication.

An intelligent discussion of Gas Enrichment manifestly requires a preliminary understanding of the various

METHODS OF ENRICHMENT.

The question of coal-gas enrichment began to assume an acute stage in the United Kingdom more than fifteen years ago, owing to the diminishing supply and increasing price of cannel. If the use of cannel were the only mode of enrichment now available, the great majority of gas consumers would unquestionably be better served by unenriched coal-gas, of the natural quality produced by the most available gas coals. Cannel enrichment is generally played out; the candle is not worth the game.

CANNEL

The "vapour-enrichment" of coal-gas is an unreliable makeshift, designed to satisfy official tests rather than as a means of practically benefiting the consumer. As usually applied, this method consists in injecting hot vapour of benzol into the gas as it enters the distributing system, but whether any of this condensable vapour reaches the consumer depends upon conditions over which the gas manager has no control.

VAPOUR-ENRICHMENT

A consideration of the nature of benzol will indicate the essential defect in this method of enrichment. Commercial 90 per cent. benzol is a liquid mixture of benzene (C_6 H_6), toluene (C_7 H_8), xylene (C_8 H_{10}), etc., of the aromatic series (C_n H_{2n-6}). Its specific gravity is about .880, and its initial boiling point about 180° F. Ninety per cent. of the mixture distils below 212° F. Below 180° the natural condition of this benzol is liquid, just as below 212° the natural condition of water is liquid. Above 180° it begins to volatilize, and at 212° is 90 per cent. vapour, just as steam is aqueous vapour. If the temperature be subsequently reduced below 180°, the benzol vapour will again become liquid, just as steam will again condense to water below 212°. In other words, benzol cannot exist in the form of a permanent gas,

but becomes partially vapourous or entirely liquid according as the temperature is above or below 180° F. Thus the attempt to supply the consumer with substantial enrichment, by injecting hot benzol vapour into the gas leaving the works, is somewhat akin to an endeavour to supply him with heat by admitting steam to this issuing gas.

But just as air may contain aqueous vapour to a degree of humidity known as the point of saturation or "dew-point," so any gas may be saturated with benzol vapour. This amount of enrichment may be regarded as permanent so long as the temperature is not lowered. The "dew-point," however, depends absolutely upon the temperature. If gas, saturated at one temperature, be subjected to further cooling in the distributing system, a corresponding deposition of enriching vapours will ultimately take place, just as dew condenses after sunset.

Now unenriched coal-gas is already saturated with benzol and co-solvent hydro-carbons to a degree dependent upon the method of condensing, and the co-ordination of temperatures during manufacture, storage and distribution. Such gas frequently contains 95 per cent. of the total benzol produced during the distillation of the coal. Therefore, to inject any considerable additional quantity of artificially heated benzol vapour into the outlet-gas creates an excess load which the gas cannot permanently carry, although some of this surplus vapour may be kept suspended in a state of fog during its travel through the trunk mains and larger arteries.

Sir George Livesey, in his paper on "The Enrichment of Coal-Gas," in May, 1900, gave the following experience of vapour-enrichment:

"Reliable evidence as to its want of efficiency is furnished by the fortnight's experiment in 1894, when all of the South Metropolitan gas was sent out unenriched, and the succeeding fortnight, when it was enriched with spirit as usual. The tests by the portable photometer were practically the same in both cases. The portable photometer results—although, as an instrument, it corresponds exactly with the official photometer—cannot be accepted as accurate, because the instrument is used under improper conditions. Still, when compared with

itself under similar conditions (as in these two series of tests), the comparison holds good. Therefore, if this complete practical experiment gave, as is believed, reliable results, the conclusion is inevitable that enrichment by spirit vapour is useless, and simply a waste of the consumers' money."

This emphatic declaration of the Chairman of the South Metropolitan Gas Company is corroborated by recent Parliamentary evidence of Dr. Frank Clowes, Chief Chemist and Superintending Gas Examiner to the London County Council. Dr. Clowes stated that his special tests of South Metropolitan gas, as it reached various important consumers, averaged 14.68 candles under the former 16-candle standard and 14.26 candles under the present 14-candle standard; whereas, according to the Company, the Works and Official tests during the same periods averaged:

	WORKS.	OFFICIAL.
Half-Year to June, 1901,	16.77	16.58
" " 1903,	14.70	14.75

It may be added that even the scant half-candle difference found by Dr. Clowes cannot be credited to the vapour-enrichment, inasmuch as the natural coal-gas was made in smaller volume per ton, and consequently of higher quality, when the higher standard was in force.

This ineffectual vapour-enrichment cannot, therefore, be accepted as a practical substitute for cannel enrichment. Hence those that will recognize no other alternative are correct, within their limitations, when they compound with Parliament for the abolition of enrichment; and Parliament, within similar limitations, is justified in abolishing a system of enrichment whereby it is admitted that the consumer pays for goods that are not delivered. It is evident, however, that such cases are an argument, not against enrichment, but against *the failure to enrich*.

CARBURETTED WATER-GAS

Broadly speaking, there is now but one intelligent method of enriching coal-gas, namely, by the admixture of carburetted water-gas of higher quality. Therefore, it may be well to recite some of the special features of that product and process, even at the risk of being considered elementary.

Carburetted Water-Gas.

NATURE

Chemically there is no such gas as carburetted water-gas or coal-gas. These are commercial terms designating the products of two industrial processes, each yielding a complex mixture of a number of individual gases. Furthermore, in spite of the different apparatus, processes and raw materials employed, there is no appreciable difference in the *qualitative* analyses of these two products. That known as carburetted water-gas contains only the elements present in coal-gas, and the two products may be mixed in any desired proportion to form an intermediate product, quite as homogeneous as either of the originals and with quite as much right, chemically, to a distinctive name. In other words, the names serve to distinguish the dissimilar methods of production rather than the manufactured products.

Essential Features.

In considering enrichment by carburetted water-gas, three essential features must be first grasped:

(a) Carburetted water-gas is not merely a means of enrichment, but is a saleable gas, in every respect as suitable as ordinary coal-gas for general distribution *per se*. Simple enrichment of otherwise finished coal-gas necessarily means additional expense; whereas the admixture of carburetted water-gas displaces an equal bulk of coal-gas. If this enriching water-gas be as cheap as the unenriched coal-gas, the cost of the enrichment is *nil*, compared with the coal-gas *per se*.

(b) Unlike coal-gas, the higher the candle-power of carburetted water-gas—within the practical limit of say 35 candles—the cheaper is its cost per candle. On this feature depends its peculiar facility for enriching coal-gas by admixture therewith.

(c) The joint manufacture of carburetted water-gas and coal-gas results in striking reflex economies in the cost of the *coal-gas*, through what are known as the "collateral" economies of carburetted water-gas.

Collateral Advantages.

These collateral advantages of carburetted water-gas may be summarized as follows:

1. Saving in First Cost of Works. Excluding the distributing system, but including storage holders, the cost of large carburetted water-gas works *per se* is about two-fifths that of coal-gas works. When auxiliary plant is dove-tailed into existing coal-gas works, the relation is more favorable to carburetted water-gas.

CAPITAL

2. Small Ground Space Occupied. The space needed for carburetted water-gas works *per se* is about one-third that needed for coal-gas works. But when carburetted water-gas plant is installed as an auxiliary in coal-gas works, no facilities are needed for receipt and storage of fuel, and the displacement and consumption of coke usually save coke-storage space sufficient for the generating plant.

SPACE

3. Wear and Tear. This total expense is about 1¼d per 1,000 cubic feet of carburetted water-gas, compared with 3½d in coal-gas manufacture.

MAINTENANCE

4. Availability. In case of need, reserve plant is immediately available, contrasted with the several days needed to bring coal-gas benches into action, and the ensuing expensive repairs. The plant can be brought, without injury, from a cold state into full efficiency in three hours. It can be kept under slow fire without appreciable expense, and can then be in free use within the hour. By thus taking up inequalities of consumption, and meeting emergencies otherwise borne by the retort house, the process diminishes the repair charge for coal-gas and reduces the necessary gas-holder capacity. Reserve plant for the same daily volume usually costs less than holder and tank, and meets a prolonged demand with a continuous profit-earning supply, whereas an emptied holder is unproductive.

AVAILABILITY

5. Increased Prices for Coke; By creating a demand on the works for coke issuing from the retorts, checking the production of coke in proportion to the coal-gas displaced, and avoiding labour and losses of stacking and handling.

COKE

6. Approximate Independence of Coal Supply. The surplus coke from each 1,000 cubic feet of coal-gas produces about 3,000 cubic feet of carburet-

COAL

ted water-gas; in other words, the make per ton of coal carbonized may be increased from 10,000 to 40,000 cubic feet.

The use of carburetted water-gas enables the illuminating power of the coal-gas to be sacrificed for a greater yield per ton of coal, and thus reduces the cost of the coal-gas per 1,000 cubic feet. In the same way, it affords free choice of gas-coals; and relatively increases the gas-coal supply by reducing the demand.

The importance of the two preceding features is illustrated by the following British figures: The present consumption of gas-coal in the United Kingdom—about 14,000,000 tons per annum—would be increased by one-seventh, or 2,000,000 tons annually, if it were not for the auxiliary manufacture of carburetted water-gas. In view of recent coal markets, it is impossible to estimate the result with gas-coals if this increased demand had existed; but it may be stated that, with an average of 33 per cent. carburetted water-gas, a saving of 5d (10 cents) per ton of gas-coal compensates a penny (2 cents) per thousand cubic feet in the cost of the carburetted water-gas.

COAL AND COKE

Likewise, a market would have to be found for 1,400,000 tons additional gas-coke per annum, if it were not for the manufacture of carburetted water-gas. In this respect, coal-gas works are now in a somewhat anomalous position, for they purvey both gas and coke for the same domestic purposes. The coke is sold at cost price, as far as comparison with the cost of coal-gas is concerned (since the whole revenue from coke is credited to that gas); but it competes with the very gas from which all profit is derived. Therefore, this 1,400,000 tons of coke, if thrown annually on the market, would tend to demoralize the present condition of the industry. It may be added that, with 33 per cent. of carburetted water-gas, an increase of 10d (20 cents) per ton in the price of coke compensates a penny (2 cents) per thousand cubic feet in the cost of the carburetted water-gas.

7. Approximate Independence of Labour. For a comparison between carburetted water-gas generating labour and coal-gas carbonizing labour (including boilers and exhausters in both cases), upon the same

LABOUR

basis and on a large scale of operation, the author would take the following general ratio :

Carburetted Water-Gas.	Coal-Gas.		
	Inclined Retorts	Machine Work	Hand Work
1	3·5	4	6 to 7

The general labour is also greatly reduced.

CALORIFIC AND CANDLE-POWER

8. Instant control of Illuminating and Calorific Power—in case of variation in coal or other emergency—by simply changing the oil supply.

NAPHTHALENE

9. Prevention of Naphthalene Deposits. When mixed with coal-gas, carburetted water-gas acts as a solvent vehicle for naphthalene. With a properly made carburetted water-gas naphthalene is unknown, and if a sufficient percentage of carburetted water-gas of good quality be mixed with coal-gas, it will largely or entirely prevent the precipitation of naphthalene from the coal-gas.

PERMANENCE

10. Permanence. If one thing has been thoroughly demonstrated regarding modern carburetted water-gas, it is essentially its permanence in distribution. The author's ample experience has convinced him that carburetted water-gas, of fifty per cent. higher luminosity, is more permanent than unenriched coal-gas. This he ascribes to the process of production, whereby certain condensable vapours—mainly benzene and naphthalene—are replaced by permanent gases.

FLAME

11. Improved Combustion. Unlike other enrichers, carburetted water-gas may be freely burned in ordinary flat-flame burners with less soot and noxious products than is the case with ordinary coal-gas. This, as just stated, is due to the process of production whereby certain coal-gas vapours are replaced by permanent gases, and to the action of its carbonic oxide in promoting combus-

tion. It is beginning to be recognized that similar benefit is realized in incandescent gas lighting.

12. Small Proportion of Sulphur. Crude carburetted water-gas contains from one-fifth to one-tenth the sulphur usually present in crude coal-gas; and, as this is almost exclusively in the form of sulphuretted hydrogen, simple oxide purification eliminates it almost completely.

SULPHUR

The last two features govern a question of importance. The most rational basis for a sanitary comparison of ordinary town-gases is probably with reference to their products of combustion, especially in view of the increasing use of flueless gas stoves. The entire population of every town is concerned with the purity of the products of combustion of the gas supplied, whereas those affected by the accidental escape of unconsumed gas represent an insignificant percentage, compared with the accidents attaching to other industries of similar extent. This view is reflected in the Parliamentary restrictions upon the quantity of sulphur permissible in London gas; although the limits have been fixed by the manufacturing possibilities of coal-gas, not by the degree of purity desirable. As it is undoubtedly a fact that one of the principal causes, if not the chief cause, of the wide substitution of electric-lighting for gas-lighting is the character of the products of combustion of the gas, the importance of improvement in this direction cannot be easily magnified.

PRODUCTS OF COMBUSTION

Value of Collateral Advantages.

From the above statement of collateral advantages, it is evident that a comparison of the ordinary bookkeeper's accounts, when coal-gas and carburetted water-gas are made concurrently, does not disclose the financial benefit resulting from the auxiliary manufacture of carburetted water-gas, inasmuch as this auxiliary effect is to reduce the cost of the *coal-gas* in many ways. Not only do the collateral economies go to the credit of *coal-gas* in the accounts, instead of being credited to the carburetted water-gas to which they are due; but the expenses by which they are accomplished (including

the coke used by the process, at the enhanced price due to the use of the process) are charged against the carburetted water-gas, thus doubly affecting the comparison of costs, *as shown by the accounts.*

In a paper read before this Association in 1899, the author endeavoured to establish a truer comparison, by reducing certain of these economies to their financial equivalents. Considering, however, merely *the interest on first cost of works* (which is as necessary a part of the selling price of the gas as is the coal or oil used in its manufacture), the difference in capital charges in favour of carburetted water-gas was found to be over 4½ cents (2¼d) per 1,000 cubic feet, when each gas is made and distributed *per se.* But when carburetted water-gas was treated as an auxiliary to coal-gas manufacture (to the extent of one-third the maximum weekly production), this difference in interest became over 9 cents (4½d) per 1,000 cubic feet *of carburetted water-gas produced* (see *Proceedings American Gas Light Association*, Vol. XVI, appendix page lv.)

Present Status.

The following figures give, approximately, the proportion of carburetted water-gas now manufactured.

The present annual output of town-gas manufactured by the English-speaking race is :

	CU. FT. PER ANNUM.
United Kingdom,	160,000,000,000
Australasia,	5,000,000,000
British Possessions,	800,000,000
Canada,	2,500,000,000
United States,	90,000,000,000
	258,300,000,000

Of this total volume of manufactured gas, one-third (86,000,000,000) is carburetted water-gas. Of this 86,000,000,000 cubic feet of carburetted water-gas, about 20,000,000,000 cubic feet, or 23 per cent., is now being manufactured in the United Kingdom.

It is now advisable to consider briefly the general

Question of Quality.

The gas industry has no longer a monopoly, although it retains monopolistic superstitions. It must struggle for existence under the general laws governing industry and commerce, the fundamental requirement of which is to give the greatest value for the least money. In Great Britain, what Parliament may be induced to grant is becoming less important than what the consumer may be induced to use. Parliament may authorize business, but whether it will be worth continuing depends upon the consumer.

The broad question, therefore, is not whether 14 or any other candle-power of gas is "good enough," but by what quality of gas, *as a vehicle*, can the maximum pecuniary equivalent in light, heat and power be delivered to the consumer? The catch-cry "cheap gas!" is very like the free-silver slogan "cheap money!" Gas, *as gas*, has no value to the consumer. Its whole value depends upon its ability to convey and develop useful energy, and that gas is cheapest which provides the maximum energy at the minimum price. That mission being fulfilled, the price per 1,000 cubic feet of the gaseous vehicle is a matter of indifference.

COST VS. VALUE

A reduction in the cost of gas, when its quality (calorific and illuminating) is maintained, is an unqualified saving; but any method of "cheapening" gas by reducing its quality, needs to be carefully weighed in order to discover if the real result be gain or loss.

"CHEAP GAS"

Cost of Enrichment.

This question has two aspects, according to whether it is desired to find (1) the cost of enriching an existing supply of ordinary coal-gas, or (2) the cost of increasing the quality of an existing mixture of coal-gas and carburetted water-gas.

IN GENERAL

In the first case, the comparison, as with other methods of enrichment, is between the cost of the coal-gas before enrichment and the cost of the enriched mixture. It involves an

exact knowledge of (a) the cost of the coal-gas, (b) the proportion of carburetted water-gas to be used, and (c) the cost of the carburetted water-gas of proper enriching quality. But (b) and (c) are inter-dependent, that is to say, the greater the proportion of carburetted water-gas, the lower its requisite candle-power and the less its cost. For instance, to enrich 14 candle-power coal-gas to 16 candles, requires 10 per cent. of carburetted water-gas of 34 candle-power, or 50 per cent. of carburetted water-gas of 18 candle-power. The difference in the London cost of 34- and 18-candle carburetted water-gas is about fivepence (ten cents) per thousand cubic feet—say, for instance, 18 pence (36 cents) and 13 pence (26 cents) respectively. The London cost of 14 candle-power coal-gas averages, say, 14 pence (28 cents) per thousand cubic feet. Then the enriched 16 candle-power mixed gas costs, with the 34-candle enricher, 14.4 pence (28.8 cents) and, with the 18-candle enricher, 13.5 pence (27 cents), per thousand cubic feet. The "cost" of enrichment is, in this case, a saving or a charge, according as the greater or less proportion of carburetted water-gas is used. This reasoning often explains discrepancies in the reputed saving or expense of enrichment by carburetted water-gas. When, however, the cost of the carburetted water-gas of the required town standard (16 candles) exceeds the cost of the unenriched coal-gas, the enrichment is necessarily an expense. (For further explanation see *Journal of Gas Lighting*, Vol. LXIV, page 864.)

But in the specific case of the Gas Light and Coke Company, the expense of enrichment is a simple question. This company is already supplying a mixture of coal-gas and carburetted water-gas in given proportions. Its district standard is now 16 candles, and it is proposed to reduce it to 14 candles. It is necessary only to know the manufacturing saving due to this proposed reduction of two candles.

IN LONDON

Assuming the entire enrichment to be by carburetted water-gas, with oil at the somewhat high average price of threepence per gallon, *the manufacturing saving will be one-third of a penny per candle; or two-thirds of a penny total manufacturing saving.*

VALUE OF ENRICHMENT.

It is now necessary to ascertain, and compare with the above saving in cost, the loss in useful effect of the same volume of gas, due to this reduction in quality from 16 to 14 candle-power.

16 VS. 14 CANDLE-POWER

The loss in useful effect will be different, according to the use that is made of the gas, viz. :

(a) Where the calorific power, pure and simple, is utilized, as in stoves and engines.

DIFFERENCE IN USEFUL EFFECT

(b) Where the incandescent effect is utilized, as by the Welsbach mantle.

(c) Where the flame-luminosity is utilized, as in ordinary burners. The nominal loss in luminosity between 14 and 16-candle standards, tested in official argands, is, of course, 12½ per cent. ; but the actual loss in common flat-flame burners is far greater.

Elaborate determinations have been made by numerous skilled observers of the 16 candle-power gas as actually supplied by The Gas Light and Coke Company, compared with the same mixture reduced to a 14 candle-power standard, tested by the method prescribed for the 14 candle-power gas of the South Metropolitan and the Commercial Gas Companies. The following results, verified by the author, are taken as representative.

I. With "C" Welsbach Burner.

The 16 candle-power district gas and the special 14 candle-power gas consisted of two-thirds coal-gas and one-third carburetted water-gas in each case.

WITH "C" WELSBACH BURNER

The same ordinary (or "C") incandescent Welsbach burner (and mantle), as generally supplied in London, were used throughout.

Each gas was burned at the rate best suited to the burner, without modification of gas nozzle.

The air was especially regulated to give the best effect with the 14 candle-power gas ; but the burner was used unregulated, as supplied to the trade, with the 16 candle-power district gas.

14 Candle-Power Gas.

	CANDLES.
14 C. P.	
1. Illuminating-Power (in "London" argand, at 16 candles luminosity, chimney 6″ x 1⅝″; reduced to 5 cu. ft. rate),	14.4
2. Incandescent-Effect (maximum light per cu. ft.—rate 3.9 cu. ft. per hour, air supply diminished),	20.3
3. Calorific-Power (Junker Calorimeter), Gross Value,	582 B. T. U.
Net "	529 "

16 Candle-Power Gas.

	CANDLES.
16 C. P.	
4. Illuminating-Power (in "London" argand, at 16 candles luminosity, chimney 6″ x 1⅞″; at 5 cu. ft. rate),	16.34
5. Incandescent-Effect (maximum light per cu. ft.—rate 3.45 cu. ft. per hour, air unregulated),	22.7
6. Calorific-Power (Junker Calorimeter), Gross Value,	628 B. T. U.
Net "	567 "

Summary.

	CANDLES.
Difference in Illuminating-Power,	1.94
COMPARISON Loss in Calorific-Power, 38 B. T. U.,	6.70%
Loss in Incandescent-Effect, 2.4 candles per ft.	10.57%

II. With "Edinburgh" Welsbach Burner.

The 16 candle-power district gas and the 14 candle-power gas consisted, as before, of two-thirds coal-gas, and one-third carburetted water-gas in each case.

The same ordinary "Edinburgh" Welsbach burner (and mantle) were used throughout.

Each gas was burned at the rate best suited to the burner, without modification of gas nozzle.

The air was regulated to give the best effect with each gas.

14 Candle-Power Gas.

	CANDLES.
1. Illuminating-Power (in "London" argand, at 16 candles luminosity, chimney 6″ x 1⅝″; corrected to 5 ft. rate), .	14.8
14 C. P. 2. Incandescent-Effect (maximum light per cu. ft.—rate 3.35 cu. ft. per hour, air supply diminished), . . .	21.4
3. Calorific-Power (Junker Calorimeter), Gross Value, . . .	582.4 B.T.U.
Net " . . .	526.8 "

16 Candle-Power Gas.

	CANDLES.
4. Illuminating-Power (in "London" argand, at 16 candles luminosity, chimney 6″ x 1⅞″; at 5 cu. ft. rate), . . .	16.7
16 C. P. 5. Incandescent-Effect (maximum light per cu. ft.—rate 3.35 cu. ft. per hour, air supply diminished), . . .	24.9
6. Calorific-Power (Junker Calorimeter), Gross Value, . . .	623.5 B.T.U.
Net " . . .	564.5 "

Summary.

Difference in Illuminating-Power, . . .	1.9 candles
COMPARISON Loss in Calorific-Power, 37.7 B. T. U., ...	6.68%
Loss in Incandescent-Effect, 3.5 candles per ft.,	14%

III. With Flat-Flame Burners.

14 Candle-Power Gas. (14.8 C. P.)

1. 14 candle-power (Parliamentary) Sugg governor burner; illuminating power	
14 C. P. for 5 cu. ft., ...	11.4 candles

16 Candle-Power Gas. (16.66 C. P.)

2. 16 candle-power new Sugg governor burner;
16 C. P. illuminating-power for 5 cu ft., 15.77 candles

Summary.

Difference in Official-Illuminating-Power, . 1.86 candles
COMPARISON Loss in Flat-Flame Burners, at 5 cu. ft. rate per hour, 4.37 candles, 27.7%

The above values are believed to represent practical use, but there are two features which must qualify the general
QUALIFYING FEATURES application of all figures connecting Incandescent-Effect with Illuminating-Power.

1. Illuminating-Power is not a true criterion of Calorific-Power or Flame-Temperature; and, consequently, not of Incandescent-Effect.
LUMINOSITY AND INCANDESCENCE Therefore, comparisons of this nature are accurate only when the base composition of the gas (*i. e.*, the diluents, H, CO and CH_4) remains relatively the same, and the difference in candle-power is due to a regular increase in the natural proportion of heavy hydro-carbons. In other words, when the comparison is between the two different qualities of the same gas, as it were; which, after all, is the real point in question.

2. Neither Illuminating-Power nor Incandescent-Effect are absolute quantities. They both depend upon the burner used
BURNERS AND TESTING and the method of testing. This latter point is now well recognized in standard tests of flame-luminosity. The difference between the argand burners prescribed for official testing in London, and in Brentford, Wandsworth, Salford, etc., represents an increase of about two candles in the official quality of London 16-candle gas; while, with the prescribed London argand, a carburetted water-gas of 20 candle-power, when burning at the rate of five cubic feet per hour, will lose nearly two candles when tested at 16 candles luminosity. There is greater difference with flat-flame burners.

But, in incandescent gas lighting, the proper adjustment of burner and gas is everything. The first principle underlying the application of gas to incandescent lighting is to use it under proper conditions of combustion. Otherwise, comparison is not only futile, but grossly misleading.

For instance, the ordinary "C" Welsbach burner (owing to its low candle-power origin) is less efficient with London 16 candle-power coal-gas than with London coal-gas of 14 candle-power. The remarkable failure to see that this is due to defects in the burner, *not* in the gas, has been chiefly responsible for the recent mistaken movement in favour of low-grade gas, and for the hitherto successful attempts to influence Parliamentary legislation by means of such mischievous evidence as the "Dessau diagram" of Messrs. von Oechelhaeuser and Schaeffer, "corroborated" by the South Metropolitan Gas Company (*Journal of Gas Lighting*, Vol. LXXV, page 1201), and the results communicated by Dr. Bunte to the Paris Gas Congress (*Journal of Gas Lighting*, Vol. LXXVI, pages 642-43), etc. In these comparisons, gases of widely different luminosity in flat-flame burners were used in *the same Welsbach burner under the same conditions of combustion, and were valued accordingly!* Those conditions, being suited to one quality only, gave the best efficiency only with that quality, and progressively poorer results according to the degree of variation from that quality. Moreover, the stated candle-powers, with flat-flame burners, bore no practical relation to the composition of the gases, inasmuch as a normal coal-gas was "benzolized," "stripped," or "doctored" in order to produce the other qualities.

DESSAU AND BUNTE EXPERIMENTS

It is common knowledge that gases of different composition and quality require different volumes of air for proper combustion, as well as different provision for proper mixture, before and during combustion, of these different proportions of air and gas. Moreover, the rate at which any gas is burned, in incandescent lighting, should be adjusted to the mantle so that the flame during combustion will exactly engage the mantle.* By observing these require-

PROPER TEST CONDITIONS

* The author directs attention to the valuable papers from time to time communicated to the Michigan Gas Association by Professor A. H. White and his associates.

ments, the Scott-Snell lamp was found by Mr. Morris to give an incandescent effect of *42* candles per cubic foot of 25-candle gas (*Proceedings American Gas Light Association*, Vol. XIX, page 307); and Prof. Lewes has obtained 146 candles by incandescence per cubic foot of acetylene (*Journal of Gas Lighting*, Vol. LXXX, page 1687). On the other hand, by violating these fundamental essentials of bunsen combustion,

DESSAU AND BUNTE CONCLUSIONS

Messrs. v. Oechelhaeuser and Schaeffer have concluded that "a decrease of 86 per cent. (from 13 to less than 2 candles) in illuminating power with the old burner was attended by an increase of 11 per cent. with the incandescent burner." Likewise, Dr. Bunte found "that great changes in the composition of the gas, which reduce the illuminating power in flat-flame and argand burners by more than one-half, or considerably increase it, and likewise greatly alter the calorific value of the gas, produce only relatively small differences in the illuminating duty with the Welsbach burner;" and upon "such a remarkable fact," he based a theory of bunsen combustion!

"And still the wonder grew," when leading British gas managers "corroborated" these irrational results, and influenced Parliamentary legislation by means of evidence diametrically opposed to the scientific facts of the case. This would seem an instance of the credulous hospitality often accorded statements that support predetermined conclusions.

But the "C" Welsbach burner, while inefficient with London 16-candle coal-gas, is, nevertheless, fairly suitable (unregulated) for the London 16-candle mixture of two-thirds

WELSBACH BURNERS

coal-gas and one-third carburetted water-gas. That is to say, this same burner is about equally adapted to the present South Metropolitan 14-candle coal-gas and to the present Gas Light and Coke 16-candle mixed gas, and gives, with the latter gas, results about ten per cent. higher than with the 14-candle coal-gas. On the other hand, the "Edinburgh" burner, which in the matter of cost is a duplicate of the "C" burner, gives (unregulated) with 16-candle London coal-gas results nearly 20 per cent. higher than the "C" burner gives with 14-candle London coal-gas; whereas

the calorific difference in these two coal-gases is about 8 per cent.

The foregoing determinations of loss in useful effect, due to the reduction from 16 to 14 candle-power, may be conveniently re-stated in the following comparative table :

COMPARATIVE TABLE	LOSS BETWEEN 16 and 14 C. P.	
	By above Determinations	Basis for Succeeding Estimates
Calorific Power	6.70%	6½%
Incandescent Effect . . .	12.28%	10%
Flat-Flame Burners . . .	27.70%	25%

Advantage of Enrichment.

At the present selling price of The Gas Light and Coke Company, viz., three shillings (75 cents) per 1,000 cubic feet, this reduction from 16 to 14 candle-power means for :

	Loss in Effect (Percentage)	Loss in Value Per 1.000 cu. ft.	Saving in Cost.	Net Loss per 1.000 cu. ft.
Calorific Power,	6½%	2.34d	.66d	1.68d
Incandescent Effect,	10%	3.60d	.66d	2.94d
Flame Luminosity,	25%	9.00d	.66d	8.34d

The net losses shown must be borne by the consumer, or by the Company, or by both jointly.

Assuming the output of gas to be utilized in the proportions given below, the

Probable Average Loss between 16 and 14 C. P. will be :

	Volume	Average Loss (Percentage)	Average Loss (Per 1,000 cu. ft.)
Calorific-Power	40%	6½%	2.34d
Incandescent-Effect	30%	10%	3.60d
Flame-Luminosity	30%	25%	9.00d
	100	13.1%	4.71d

PROBABLE PRESENT ADVANTAGE OF 16 C. P.

Average Loss in Useful Effect.	Value of Loss per 1,000 cu. ft.	Saving in Cost.	Net Loss per 1,000 cu. ft.
13.1 per cent.	4.71d	.66d	4.05d

On the proposed basis of a compulsory compensation of twopence in the price of gas for the two candles reduction in quality, this means a loss to the consumer of (4.71 — 2.00) = 2.71d per 1,000 cubic feet, *and* a loss to the Company of (2.00 — .66) = 1.34d per 1,000 cubic feet. Or, reckoned on the Company's present sale of 21,000 millions cubic feet, a loss to consumers of £237,000 ($1,150,000) per annum, and to the Company of £117,000 ($570,000) annually; being a total net loss of £354,000 ($1,720,000) per annum.

In the light of these figures, the Company could not intelligently adopt a 14 candle-power standard, even were it authorized without compensation to consumers. An expenditure of two-thirds of a penny for a present saving of probably 4.7d to consumers, could not be considered other than a prudent and economical insurance of the stability of the business.

It is possible that the gradual evolution of more perfect burners may reduce the above discrepancy between the difference in calorific power (6½%), and the difference in incandescent effect (10%); but, inasmuch as the richer gas has also a somewhat higher calculated flame-temperature—apart from its greater calorific power—it is not probable that this discrepancy will be altogether eliminated.

If, however, this possible future change be discounted, by grouping incandescent effect with calorific power; and, moreover, the consumption allotted to flat-flame burners be halved,—

MINIMUM FUTURE ADVANTAGE OF 16 C. P.

The minimum prospective loss, due to a reduction from 16 to 14 candle-power, becomes:

	Volume	Average Loss (Percentage)	Average Loss (Per 1,000 cu. ft.)
Calorific-Power, Incandescent-Effect	85%	6½%	2.34d
Flame-Luminosity	15%	25%	9.00d
	100	9.27%	3.33d

Average Loss in Useful Effect.	Value of Loss per 1,000 cu. ft.	Saving in Cost.	Net Loss per 1,000 cu. ft.
9.27 per cent.	3.33d	.66d	2.67d

Hence, this minimum future loss would be: to the consumer 1.33d per 1,000 cubic feet, or £116,000 per annum, and to the Company still 1.34d per 1,000 cubic feet, or £117,000 per annum; being a total annual prospective loss of £233,000, reckoned on the present output.

UNDER SLIDING SCALE

But under the practical operation of the Parliamentary Sliding Scale (which establishes a community of interest between consumers and shareholders) the distribution of profits is in such relation to the price legally charged that the consumers bear nearly the whole of the above losses; *i. e.*, the loss directly ascribed to them and about four-fifths of the loss ascribed to the Company. We have, therefore, the curious spectacle of the consumers' guardian (in the guise of the London County Council) promoting legislation, in the supposed interest of the consumers, the immediate effect of which would be a loss *to the consumers* of about 3.75d per 1,000 cubic feet of gas consumed. It has remained for the most maligned of English Gas Companies to successfully resist this wasteful movement, in opposition, not only to recent Parliamentary precedents effected by acknowledged leaders of the industry, but to the Local Authority (representing the consumers), and to an influential section of the technical press.

THE CASE FOR LOW-GRADE GAS

If the foregoing values are correct, the case for 14 *versus* 16-candle gas in London falls hopelessly to the ground. It only remains, therefore, to ascertain whether the evidence advanced in favour of low-grade gas qualifies in any way the above conclusions. To this end (and somewhat by way of a summary of the preceding pages) it will suffice to traverse briefly the public arguments of Sir George Livesey, Chairman of the South Metropolitan and Crystal Palace Gas Companies, Director of the Commercial Gas Company, and undisputed leader in Great Britain of the current low-grade movement.

COST AND TROUBLE OF ENRICHMENT

In his paper "The Enrichment of Coal-Gas" (*ante* page xv), Sir George Livesey states that there are "only three systems in general use:" with reference to cannel enrichment "its cost puts it out of court;" "enrichment by spirit vapour is useless, and simply

a waste of the consumers' money ;" "and carburetted water-gas is objectionable from its nature and the difficulty and uncertainty of mixing."

Sir George Livesey has had wide experience with cannel and vapour enrichment, and the author fully concurs in the conclusions drawn therefrom. But facts permit carburetted water-gas to be dismissed in this fashion—only by one who could also avow "I know nothing of water-gas and I am rather glad I do not" (*Proceedings Inst. C. E.*, Vol. CXLVI, page 83)—notwithstanding that carburetted water-gas already forms one-third of all town-gas manufactured by the English-speaking race (*ante* page xxii).

To better gauge the bias that characterizes any improvement of common coal-gas as "adulteration," let us imagine for a moment the original introduction of coal-gas and carburetted water-gas in reverse chronological order. Suppose that the British gas manager had devoted his life to carburetted water-gas, and that a foreign development called coal-gas were being urged upon him. The argument in its favour would analyze somewhat as follows :

It is true that the proposed coal-gas requires twice the capital expenditure, three times the ground area, from three to six times the manufacturing labour, and large additional operations in residuals, since only 20 per cent. of the coal purchased can be converted into gas ; moreover, the new gas is limited to (say) 14 candle-power, and the individual services are subject to stoppages from naphthalene ; the presence of benzene and naphthalene make it less permanent than the existing supply, and it contains many times as much sulphur ; its combustion is less perfect, owing largely to the presence of less carbonic oxide, and it yields more offensive products ; and, for the same quality, its average holder-cost is generally more—often much more. But, against such disadvantages, *there is the satisfaction of supplying "unadulterated" coal-gas, made from* [now increasingly scarce] *British coals !*

In these circumstances, who would even consider the *complete substitution* of coal-gas for carburetted water-gas ? Yet, an equivalent result prevails to-day in many of the British gas works that do not practice the auxiliary manufacture of

carburetted water-gas. As already pointed out in detail (*ante* pages xvii-xxi), this auxiliary manufacture of carburetted water-gas not only affords a perfect means of enrichment, *but also largely eliminates the disadvantages of coal-gas per se;* moreover, it realizes important opportunities that attach to the system of *dual manufacture*, and that are lost when either gas is made exclusively. One such feature is illustrated in Sir George Livesey's Parliamentary testimony, May 3, 1900: "The crucial point is whether the consumers shall have gas at all—not whether it shall be a candle more or less. The largest gas works in London were recently within six hours of exhausting their supply of coal. We have been hovering for weeks on two days' supply; and what we are to do this year I do not know." The then coal crisis was due, not to strikes or *force majeure*, but to commercial and trade conditions resulting from general industrial prosperity—which it is to be hoped, may be oft-recurring.

In the face, therefore, of merely sentimental and imaginary objections, it may be reasonably held that the ease and cheapness of enrichment by carburetted water-gas, as specifically stated herein, remains established.

Next, as to the *value* of enrichment—quoting from Sir George Livesey's paper:

DISADVANTAGE OF ENRICHMENT

"No one can seriously argue that the slightly higher calorific value of enriched gas, even if the enrichment reaches the consumers, is desirable for heating, cooking, power and trade, or manufacturing purposes. A lower price rather than the higher quality is what consumers want; and as to incandescent lighting, experiments made in Germany (and corroborated in England) have proved that with the Welsbach burner the light actually increases as the illuminating power of the gas diminishes. To illustrate this point, diagrams showing the result of the German and English experiments have been prepared; for to a fact of such great importance special prominence must be given."

From this text, inspired by the "Dessau diagram" and similar experimental follies (*ante* pages xxviii-xxx), was developed the Parliamentary evidence that secured the Acts of 1900 and 1902, reducing the illuminating standard of the South Metro-

politan and Commercial Gas Companies from 16 to 14 candle power.

The foregoing pages have demonstrated—what must be self-evident to any impartial mind—that the *quality* of gas is neither immaterial, nor yet a positive disadvantage; but, on the contrary, that the above statement is based upon violation of the first principles of combustion, and is diametrically opposed to fact.

Again, with reference to flat-flame burners:

"Consumers have it in their power, even with ordinary burners, to increase or diminish the light obtained from the gas to a far greater extent than the difference produced by enrichment.

"In illustration of this point, the burners (flat-flame) of fifty consumers taken indiscriminately, who lately complained of a bad light, were tested. The illuminating power yielded by these burners ranges from 6 to 17 candles. The gas used was of 16 candle-power, burnt on the best conditions as to pressure and quantity for obtaining the most light—more than the consumers would obtain, because they would not burn under those conditions. Of the fifty burners, the highest result per foot of gas, calculated to 5 feet per hour, was 16.9 candles, and the lowest was 6 candles. There were three over 16 candles, two under 7 candles, and fifteen (or 30 per cent.) under 10 candles. These complaints, as is the case with all others, were remedied, not by increasing the illuminating power of the gas, but either by changing the burners or improving the supply of gas."

Here we have Sir George Livesey's evidence that 16-candle gas, under proper governing, will give 16 candles in a suitable flat-flame burner; against his later Parliamentary evidence (June 30, 1903), "The consumers had used bad burners which gave on the average 9 candles."

Instead, however, of encouraging his consumers to use burners which would increase their average light (for the same consumption) from 9 candles to 16 candles, he advocates a poorer quality because, even with 16-candle gas, consumers with "bad burners" get a poor light! To sustain his case, he undertakes to supply all his consumers, without charge, with

governor burners especially constructed to give the maximum light with 14-candle gas. It transpires, however, that this new burner gives about 11½ candles with 5 cubic feet of 14-candle gas, whereas the similar burner for 16-candle gas gives about 16 candles (*ante* pages xxvii-xxviii).

It is evident that the illogical attempt to disparage 16-candle gas, on the ground that this perfect "new burner" gives a better light with gas of 14 candle-power, than "bad burners" give with nominal 16-candle gas, in no way qualifies the author's previous conclusions.

SOUTH METROPOLITAN CONSUMPTION

We may now pass to the final phase of the current case for low-grade gas, namely, the evidence of the South Metropolitan Gas Company that, since their adoption of the 14 candle-power standard, no more gas has been consumed than would be accounted for by normal increases. This is cited by advocates of low-grade gas as conclusive proof that 14-candle gas is as good for the consumer as gas of 16-candle power. The South Metropolitan circumstances do not warrant such a conclusion:

First and foremost, the South Metropolitan Company employed vapour-enrichment, when under the 16 candle-power standard, and admittedly did not supply 16-candle gas to their consumers. We have the specific statement of the Chairman of the Company, corroborated by the Parliamentary evidence of the Chief Chemist and Superintending Gas Examiner of the London County Council (*ante* page xvi), that the gas delivered to the consumer, with and without enrichment, was of practically the same candle-power. Their Chairman stated in Parliamentary evidence (May 3, 1900): He had never understood that they were to supply 16-candle gas to every consumer, but that it was to be 16 candle-power as sent out from the works, and that gas of 16 candle-power was to be found at the testing stations. "My opinion is that if Parliament had intended 16-candle gas to be given everywhere, it would have required us to supply 17 candles."

No one denies that the company have lived up to this limited sense of their obligations, and that their works and official tests have satisfied the legal standard; but, inasmuch as their method of vapour-enrichment was worthless, the fact

remains that practically the same gas reached the consumer before and after the abolition of their so-called enrichment. Hence, there is no reason why an abnormal increase in consumption should have followed the abolition of such enrichment.

Secondly, coincident with the company's adoption of the 14 candle-power standard, their consumers were supplied *gratis* with special governor burners giving about 11½ candles with 14 candle-power gas in the place of "bad burners which gave on the average 9 candles." Also, the energetic policy of the company in extending incandescent gas lighting effected substantial saving in the consumption of gas. To quote the Chairman at the last half-yearly meeting of the South Metropolitan Company:

"What the company have done has been to supply, under their act, new and improved burners—the best burner that could be obtained or could be made for burning ordinary gas on the flat-flame system. We have supplied these by hundreds of thousands to our customers in exchange for burners that did not, many of them, give much more than half the light that is now obtained from these improved burners with a lower quality of gas. Then there is another great improvement in the consumption of gas by means of the Welsbach incandescent mantle. We have now a very large staff of men —between 60 and 70—engaged at the present moment in doing nothing but visit the consumers and attend to their incandescent mantles. Well, the result of the recent introduction of the improved flat-flame burners, whereby the illumination is nearly doubled compared with that obtained from the old and unsuitable burners, and of the incandescent mantle, whereby the light is increased about sixfold, is that the consumers burn less gas."

It is needless to mention other argumentative questions involved in a general comparison of this character. Enough has been said to show that the comparative outputs of the South Metropolitan Company, during and after their attempted enrichment, have no bearing upon the comparative values of 16- and 14-candle gas.

On the other hand, it is seen above that low-grade zealots

"blow hot and cold with the same breath." They obtain relief from a useless method of enrichment, because it does not reach the consumer, and they accompany its abolition with the most comprehensive and enlightened means of saving gas; then, because an abnormal increase in gas consumption does not follow the abolition of this nominal enrichment, they declare that 14-candle gas is conclusively proven to be as good as gas of 16 candle-power, and that all "theory" must consequently be flung to the winds.

In the Crystal Palace Co.'s recent attempt to reduce their illuminating standard from 15 to 13 candle-power, their Chairman testified (June 30, 1903):

"*The company proposed to give the consumers the whole of the saving. They found that the enrichment cost them ½d a candle; and that being so, if they reduced the selling price a penny, they would give the consumer all the saving.*"

Here is a bill, promoted ostensibly in the sole interest of the consumers, that proposed to compensate them one penny per 1,000 cubic feet (or 3¼ per cent.) for a reduction in standard quality of two candles (being 13⅓ per cent. by photometric standards, and *over 25 per cent. in flat-flame burners*), notwithstanding the company's testimony "that 36.6 per cent. of the gas supplied by the company was used for heating, cooking, engines and incandescent lighting; the remainder [63.4 per cent.] being used in flat-flame burners!"

The author thinks he may now end his "cross-examination," without qualification in the conclusions he has previously established herein.

DILUTION OF COAL-GAS

With such a case for enrichment, it is scarcely necessary to refer to the foolish attempts *to dilute coal-gas* by the admixture of blue (or lightly-carburetted) water-gas, although the author has been to some trouble to ascertain what the present advocates of this plan have to say in its favour. Their policy appears to have no other foundation than the superstition that "consumers care nothing for quality, what they want is 'cheap' gas," sometimes supplemented by the erroneous assumption that greater economy attaches to the manufacture of blue water-gas in the Dellwik generator than in the Lowe process. This idea of

"cheap gas" has been already referred to under "*Question of Quality*," and for a detailed exposition of this issue the author would refer to his letters on "Flame-Luminosity and 'Cheap' Gas," and on "Blue Water-Gas," in the "*Journal of Gas Lighting*," March, April and May, 1902, and February, March, April and May, 1903.

Finally, *with reference to American conditions:*

IN AMERICA

With similar gases, the advantage of enrichment is greater in America than in London, because

(a) The average cost of enrichment is somewhat less in America—say, one cent for the two candles, against .66d in London; and

(b) The average selling price of gas, in common with most commodities, is considerably higher in America—being $1.035 per 1,000 cubic feet, by the census of 1900, against 75 cents in London.

Hence, in America, the London situation would average as follows (see page xxxii):

RESULT OF REDUCTION FROM 16 TO 14 CANDLE-POWER.

Average Loss in Useful Effect.	Value of Loss per 1,000 cu. ft.	Saving in Cost.	Net Loss per 1,000 cu. ft.
13.1 per cent.	13.5 cents.	1 cent.	12.5 cents.

SOME FEATURES OF MUNICIPAL OWNERSHIP.

Written for the Thirty-first Annual Meeting of the American Gas Light Association by Henry L. Doherty, New York, N. Y.

The agitation for municipal ownership is largely a fad, but one which is injurious both to the public and to privately owned municipal utilities. It is a handicap on the legitimate development of utilities which is frequently responsible for inadequate service from a geographic standpoint and poor and uneconomical service where it does exist. Some of the men who pose as the "friends of the people" in advocating municipal ownership are often sincere, although other advocates are prompted by the same motives which actuate the spider to invite the fly to his web, and yet it seems to never occur to these men that in continually threatening private enterprises with municipal opposition they are curtailing the credit of the private business, rendering it impossible for it to secure funds on a sufficiently advantageous basis to enable it to give good and adequate service and to provide new and modern equipment which will enable it to supply service at lowest cost. This continual threat of municipal opposition has already discredited private undertakings to an extent which probably prevents many small communities from enjoying the benefit of gas and electric plants, although able to support such enterprises. Take away this continual threat of competition, and gas and electric securities will have the same value they now have at an interest rate one-third less. The politician has nothing to lose from this agitation, but the public and you gentlemen have. The burden of demonstrating the actual degree of success or failure of municipal ownership must therefore rest with you. It is a question which can be permanently disposed of by honest and determined treatment.

We must give municipal ownership credit for such advantages as it enjoys, and we must not only be willing to show the shortcomings of private ownership and corporation misconduct, but we must help expose these shortcomings, correct misconduct and seek means for improvement.

If we are going to give municipal ownership thorough consideration, we must start from fundamental facts and consider questions of an elementary character.

Conditions Which Prompt Municipal Ownership Agitation.

An element of the principles of radical socialism always influences the consideration of this problem. Fully ninety per cent. of the people of this country unconsciously have socialistic tendencies, although the very large majority of them would vehemently resent being classed as socialists. If we should all share alike, regardless of ability and industry, and divide with each other and re-divide as frequently as possible to maintain equilibrium, then this argument would be a waste of time. We must therefore assume for the sake of a point from which to start that radical socialism is both impossible and inequitable.

The Necessity and Value of Power to Incorporate.

The general dislike with which the public regards corporations is due entirely to their inability to see anything more than the real and apparent wrongful acts of corporations. They overlook the theory which gave the corporation birth, and fail to appreciate the great factor corporations have played in the advancement of the welfare of all classes and especially to the middle and laboring classes. There are certain laws of economics which are as fixed as the laws of gravity and which cannot be changed or influenced by public will or sentiment. Some enterprises by their very nature require a large aggregation of capital to realize the economic conditions fixed by these natural laws. Labor-saving machinery must be provided, and to secure the full advantage of the division of labor, operations must be conducted upon a gigantic scale. If the

law did not provide for the co-operation of men of small or moderate means, these enterprises would be open only to those possessed of large means. As only the very rich would possess sufficient means, these opportunities would be open only to the few, and for lack of competition these few rich people could make these opportunities as productive as their greed might dictate, and we would then in reality have the condition of "the rich getting richer and the poor poorer." The rich man's dollar could be made to realize forty or fifty per cent. profit, while for lack of opportunity the poor man's dollar could be made to earn but one or two per cent. But the opportunity for several or many men to combine their capital makes each one of the poor man's dollars worth just as much as the rich man's dollar, and this feature of the beneficial results of the existence of corporations is seldom recognized or given consideration by the public, due to the lack of proper thought and study, and to the prejudice that is instilled in the public mind by a socialistic press and a socialistic pulpit.

Radical socialism is an irrational plan for the division of the fruits of labor regardless of worth and merit. The opportunity for the co-operation of capital and labor through lawful incorporation not only offers a means for the equitable division of the fruits of labor, but renders possible the realization of the benefits of economic laws which add to the productiveness of labor, capital and thought to a sensational degree. As an example of the increased production due to combination of capital to provide labor-saving machinery and to secure the advantage of an economic division of labor, it is now said to be possible for one workman to produce as large a quantity of nails, and of a better quality, than was formerly produced by fifteen hundred workmen.

Opportunity for co-operation by means of legal incorporation is the friend of the poor man, but of no particular benefit to the rich man. But why theorize on this point when conclusive evidence can be offered? If this position was not correct, only the rich man's son would have a chance to become a man of affairs. Nearly a generation is required for a demonstration of this example, and we cannot see a gen-

eration ahead. We can, however, go back a generation and trace history down to our present day. Who are the men of affairs of to-day? Surely they are not exclusively the sons of the rich of the previous generation. They are largely the sons of the poor minister, the farmer and the mechanic. Some of them, it is true, had rich fathers, but this does not absolutely disqualify a man if he has industry, ambition and merit. Make a list of the men of affairs, and for every rich man's son you can find amongst them, others can point out five who were born and reared in humble circumstances.

This is the theory, effect and result of co-operation, which is synonymous for legalized incorporation.

Is this the system that we should aim to tear down because it does not meet favor with a few radical socialists?

Admit that their motives are good, and the fact still remains that they are unconsciously attempting to turn back the wheels of progress. They say the system is wrong, and perhaps it does shield some wrongs, but surely we should aim to improve conditions and eliminate the wrongs rather than eradicate the system. Because it may be beneficial to the rich man it would not be right to deny its advantages to the man of poor or moderate circumstances. Legalized incorporation is merely a convenience to the rich man, while it is a necessity to the man or men of meagre or moderate means.

The Effect of Further Development of Co-operation.

What we want is further co-operation rather than the destruction of what we already have. Politicians are striving to divide the public into one class which invests, and another class which works. After this division has been secured the politician and demagogue can easily work up class prejudice —in fact, he has already done so. The future of American supremacy depends first upon checking this class division, and then upon the amalgamation of the classes. The truest American is the man who both invests and works. A large element of the investing class is already composed of the hardest workers in the world. It only remains for more of the working class to be made investors. If they of the working class can live at all in times of depression, they can, in times

of prosperity, such as the period we are now passing through, become investors. It remains only for the organizers of incorporated companies to issue securities in such small amounts as to be available for sums of money no larger than fair sized individual savings bank deposits, and for the co-operation of those having influence with the members of the working class to induce them to become investors. With proper study of means on the part of financiers and economists and by honesty and proper spirit for treatment by both the investing and working classes, the interests of the two classes can be made almost identical. Participation by ownership of stock in incorporated companies is the only equitable and rational means of co-operation and profit-sharing which is generally available. The masses of the American people are abundantly able to invest something in the securities of incorporated companies, under proper conditions, if they have confidence in the undertaking and its management.

Municipal ownership is advocated largely on the grounds of universal co-operation. At first glance it "looks good," but after careful study it will be found to be neither expedient, rational, equitable nor desirable; while co-operation by legalized incorporation offers a rational, equitable and desirable system of co-operation especially if it can be rendered more available to all classes. If this dream could be realized, incorporation would become a means of almost universal co-operation and a savings bank for the masses.

Is There Any Good Reason for Municipal Ownership?

We are now ready to consider the wisdom and effect of a city acquiring control of public service properties. The scheme finds considerable advocacy, and if there is any reason why a city should embark upon a business enterprise, this reason should not be in discord with wisdom. There also should be a satisfactory reason for selecting this particular class of a business enterprise upon which to embark.

These questions have been asked of many municipal ownership advocates, but their answers have been either too scattering, vague or illogical for any concrete impression to be obtained. Their advocacy of municipal ownership is due

largely to sentimental reasons, prompted by innate socialism and dislike for corporations, supplemented by misapprehension of the profits of the business and the lack of knowledge of the disastrous results which have followed municipal undertakings in many cities other than their own. As no uniformity of opinion seems to exist on this side of the question, I will consider all of the reasons which have been offered to justify municipal ownership. They are as follows :

1. To render impossible the ownership of a public utility by non-residents.

2. To enable the plant to be operated for the greatest good to the greatest number.

3. To protect the public from fraud.

4. To break up monopolies.

5. To prevent the use of public thoroughfares for private gain.

6. To yield a profit.

7. To cheapen the cost to users.

8. To insure good service.

9. To insure equitable division of profits from municipal utilities in the interests of all citizens.

10. To insure protection of employees of all public utility companies.

11. To enable the city to have employment patronage that it can distribute amongst the needy.

12. To prevent desirable positions from being given to men imported from other cities.

13. To protect municipal officers from temptation.

14. To purify politics, raise the standard of municipal officers and secure honest administration of all public trusts.

15. To compel citizens to take an interest in public affairs.

16. To assist in raising the standard of living amongst the poorer classes by supplying them with public service at operating cost.

17. To secure ownership by the people for the elevating effect of citizenship.

It is unnecessary to express opinions of these reasons, for they must be measured by an exact standard. When the framers of our Constitution used the phrase "the greatest

good to the greatest number," they probably thought it unnecessary to qualify the statement so that it should not crucify the fundamental law of justice, but modern municipal ownership advocates often interpret this phrase to read "the greatest good to the greatest number regardless of justice." For the preservation of the American people, their motto and watchword must be "Justice." Any policy inconsistent with justice must be rejected. Their purpose and their reasons therefore should permit:

1st. That justice must prevail.

2d. That truth and experience should not be disregarded.

3d. That matters of opinion should appeal to common sense.

We will take up their reasons and measure them by the standards outlined above.

1. "To render impossible the ownership of public utilities, by non-residents."

This reason is not always in accord with the third condition, "Common Sense." When quasi-public utilities are sold by local investors, the money is generally re-invested at home. The city still has its public utility company, and the money paid for it generally goes to create or support other local industries and often to the great benefit of that particular city. This is not a guess, but a statement upon which absolute evidence can be furnished.

2. "To enable the plant to be operated for the greatest good to the greatest number."

This would not always accord with Justice. Examples can sometimes be made most impressive by exaggeration. Let us assume that a city has one taxpayer and 1,000 light users. Acting upon the reason given, some people would advocate supporting the light plant entirely by taxation and furnishing light to the citizens without cost. This is simply an exaggeration of the condition which generally prevails under municipal ownership. Service is furnished at less than real cost and the taxpayers make up the deficit.

3. "To protect the public from fraud."

This reason does not meet the second condition—"Truth," or the third condition—"Common Sense." Fraud is impossible without collusion between the manager and many of

his employees, and it would be impossible for him to enter into criminal collusion with them without subjecting himself to blackmail and to loss of authority.

4. "To break up monopolies."

This reason does not meet the second condition—"Truth." The average gas or electric company can be a monopoly, but most of these companies have found that it does not pay to assume this position. A certain amount of business can be demanded and held at monopoly prices, but maximum profits can only be realized by cutting prices to the lowest possible limit and competing with every other medium available for light, heat and power. The gas and electric company which is keeping within its monopoly limit is almost a thing of the past, if not entirely gone.

That you break up a monopoly by municipal ownership is untrue. You simply change its nature and render the monopoly feature absolute. Every avenue for redress which is open to the aggrieved consumer against the city was also available against the private company, and many opportunities for redress to the aggrieved consumer which were open against the private company are not open to the consumer against the city.

5. "To prevent the use of public thoroughfares for private gain."

This reason does not meet the first condition—"Justice," or the third condition—"Common Sense." That is exactly what the thoroughfares are for, and if their use is forbidden to one it should be forbidden to all. The average gas and electric company transmits annually over or under the public thoroughfares the equivalent of thousands of tons of coal. They do not injure the thoroughfares nor the adjoining property, for the transmission is not accompanied by wear and tear of the streets nor by noise. If all light and fuel were transmitted in the same manner, the city would be saved considerable street repair expense and the streets would be free from dirt and noise.

6. "To yield a profit," and

7. "To cheapen the cost to users,"

are almost synonymous. These reasons bring up the real

bone of contention. At first glance it looks as though the city could at least save the profit of private ownership, and without further thought or investigation the average man assumes that the city could either make a profit at the same price or sell at a much less price if no profit were exacted. But the wrecks strewn along the path of municipal ownership history disprove this, and if known to the average hard-headed and practical American citizen, would offer evidence of a more conclusive character than the flowery word-pictures of the man who habitually talks, but seldom works, or the polished rhetoric of the student of economics who has so diligently studied books that he has had no time nor inclination to study men. The problem which therefore presents itself is the question of the relative economy of operation under municipal and private ownership. The city has the one advantage of a larger credit which generally permits it to borrow funds at a lower rate of interest. Beyond this apparent advantage, it has no other advantage worth mentioning, while the private corporation has unlimited advantages of every other character. The margin of difference between profitable and unprofitable management is not so wide but that even one of innumerable elements, which, to the inexperienced, may seem of relatively small importance, is easily sufficient to cause a profitable private undertaking to become an unprofitable municipal undertaking. Municipal ownership not only offers an opportunity for this mismanagement, but positively invites it, or, to be even more exact, compels mismanagement. The city's advantage in obtaining money at a lower rate of interest is more apparent than real. The lower rate of interest is largely due to the wider margin of difference between the total bonded indebtedness and the property which secures this indebtedness, and as this margin of difference is trespassed upon, the interest rate goes up, not only on the bonds issued for the purchase of public utilities, but also on all other city bonds. It does not require a very heavy advance in the interest rate on all of the city's bonds to wipe out all possible advantage on that score and to cause the city many thousands of dollars' loss, all to satisfy a craving to embark upon a business enterprise.

Austin, Texas, furnished an example of what may happen

from an epidemic of the municipal ownership disease. When the bubble of promises made by irresponsible seducers of the public's judgment finally burst, the bondholders had to face the problem of accepting whatever compromise the city might offer or else suffer the repudiation of the bonds by the city. It is not out of place to call the attention of the practical American citizen to the fact that one city cannot revel in municipal ownership to the extent that it becomes necessary to repudiate its bonds without a slight discrediting effect on the bonds of all cities, and especially on the bonds of those cities which seem to have an itching to embark upon business undertakings. Eliminate this constant threat of municipal confiscation or competition and give the private company reasonable protection in its investment, and it will be able to secure funds on about equal terms with the city.

Does any reasonable human being believe there can be the same interest and loyalty on the part of the operators of a municipal undertaking that there is on the part of the operators of a private undertaking? No matter how sincere any one or more of the operators may be, the general average must of necessity be much lower.

The manager, engineer, and all other employees of municipal undertakings, must be (1st) residents of that particular city, (2d) members or perhaps leaders of a certain political party, (3d) members in good standing of the dominant clique of that political party, and last, but not least, they are generally selected purely for their political ability, without any or with little regard for the qualifications they should possess for the position they are to fill. Is it any wonder that the history of municipal ownership is a record of failures? Assume again that there is a $2,000.00 per year position to be filled with a municipally owned plant. Do you suppose for a minute that any man who can command the same salary with a private company would accept it and subject himself to the unmerciful criticism that is apt to follow political employment, with the prospect of finding himself out of employment at the next turn of the political wheel? As a rule, the man accepting political appointment as an engineer recognizes the lack of opportunity for advancement offered him in his profession,

and he therefore is not inspired to the same excellent work as that which stimulates the man usually found employed by a private company. If ambitious for advancement, it is of a political character, different from that of his professional work, and he is therefore not seeking proficiency in a professional capacity, but is probably seeking proficiency in the art of being a "good fellow," even though the attainment of his ambition in this direction must be at the city's expense. The above, for the most part, refers to conditions under the "Spoils System," and in view of former municipal ownership failures it is generally conceded, by even the most pronounced advocates of municipal ownership, that success under this plan is impossible. Some of them who are sincere actually feel that this has been the real and only cause of past failures, and all agree that this offers an excuse by which these failures may be explained. Civil service, they tell us, will change the history of municipal ownership from one of failure to one of success. For my own part, it is a question between the two systems. As a rule, a politician who cannot juggle civil service to secure the appointments he wants is unworthy of his calling. For certain classes of work, ability to pass a prescribed examination in geography, rhetoric, etc., is of no more significance than to have a certain prescribed length of the big toe. If a man has a bad breath, an ugly disposition, is lazy, or has a bad memory, the fact that he knows how far the earth is from the moon does not render him particularly more efficient. But the fact that he knows that his superior officer cannot remove him without good cause (which may mean for nothing less than stealing, fighting or getting drunk), is enough to render him an absolutely worthless employee. Civil service is a guarantee to the employee that he does not have to be any better than the prescribed minimum. He can be lazy, slightly insolent to his superior, instigate trouble, and discourage and disgust other employees, and the magnanimous cloak of civil service will shield and protect him. Civil service, as it generally exists, is one of the funniest jokes of the present century. I think the degree of failure of municipal ownership is apt to be just as pronounced under Civil Service as under the Spoils System. Civil service and other such

restrictions are the result of the knowledge, secured by experience, that unrestrained a public officer can be relied upon to misconduct his trust; but it probably has never occurred to many people that every restriction placed upon a public officer curtails his opportunity for good management more than it curtails his opportunity for corrupt practice. The very necessity for these restrictions is evidence of the impossibility of successful municipal management.

The ability of a city to operate a public utility plant at a profit at the rates charged by private plants is extremely doubtful. Or, stated in a slightly different way, it has not been proven that a municipally owned plant can furnish service any cheaper than can a private plant. Some examples are cited as evidence of the ability of municipal plants to furnish service at lower rates than private plants; but the reports furnished are not of a nature that would satisfy a close observer with an unprejudiced mind. Admitting for the sake of argument that the claims of the advocates of municipal ownership regarding these alleged successful plants are true, the fact still remains that for every success which they claim, at least two demonstrated failures can be cited.

Neither of these two reasons, therefore, meet our second condition, "Truth."

8. "To insure good service."

Probably none of the reasons cited are quite as much out of accord with our second condition, "Truth." No opportunity for good service is open to the city which is not available to a private plant, and few of the opportunities open to a private plant are available to the city plant. The inaccuracy of this claim is too easily demonstrated to demand any extended treatment at this time.

9. "To insure equitable division of profits from municipal utilities in the interests of all citizens."

This is another pretty dream, born only of sentiment, which needs but slight analysis to dissipate.

The taxpayer is compelled to assume the risk of the success of the plant, and many of the citizens, and perhaps a majority of them, assume no responsibility for the risk. In many cities we have the absurd condition which permits a city to embark

upon a business proposition if supported by a popular vote of the citizens. One can easily imagine a condition whereby a majority of non-taxpaying citizens would, against the wish of the taxpaying citizens, authorize the city officials to embark upon a business enterprise necessitating the creation of debt, for the satisfaction of which the property of the tax-paying and non-consenting citizens would be pledged. It is also easy to imagine a condition whereby a number of small taxpayers and large light-consuming citizens would outvote nearly an equal number of large tax-paying citizens. This condition is inequitable and unjust, and to admit the fact that inequity to this degree is just, is sufficient warrant for the logical conclusion that direct confiscation of property is not unjust. To restrict this vote to the taxpayers only would offer greater equity; but all taxpayers are not voters, and while each voter is given an equal voice the risk is not equally divided, but depends upon the tax division. No matter what conditions prevail, justice does not warrant a majority in pledging the property of a non-consenting individual to a risk which will not benefit him, but which will in all probability harm him.

If the plant proves to be profitable, it is probably due to the fact that the light-consumer is overcharged, and you then have the condition of the light-consumers contributing unequally for the benefit of others.

Assume the plant is mismanaged and requires the collection of an excessive amount from the consumer. What means has he for redress? The laws of some States forbid the supply of service at less than cost, no matter how excessive this cost may prove to be. Misapprehension of the future good of the citizens has prompted some States to forbid, by statute, the granting of competing franchises for the supply of light, heat and fuel, and also to forbid the relinquishment of a municipal plant when once acquired. Prate about breaking up monopolies if you will, but under these conditions municipal ownership becomes the most pronounced, oppressive and odious monopoly that could well be imagined; a monopoly placed in the hands of politicians, a class of people commonly designated by the press of the country as incompetent and insincere. Here is a condition where the city must charge the full cost

for service, no matter how excessive this may be, no franchise can be given to competing companies, and the city is forbidden to relinquish the plant, no matter how much loss may be occasioned. The whole question, when closely analyzed, is a grave reflection upon the study and thought that the American public bestows on public questions, and this very condition, which the press so bitterly complains of, is conclusive evidence that the American people cannot and will not neglect their own private business in order to keep in touch with the conduct of public officers, and to inform themselves to a degree which will enable them to determine their willingness and ability to intelligently and honestly conduct public affairs.

10. "To insure protection of employees of all public utility companies."

11. "To enable the city to have employment patronage that it can distribute amongst the needy."

12. "To prevent desirable positions from being given to men imported from other cities."

To argue against these reasons would almost be an insult to American intelligence. A passing comment, however, is not out of place.

Here are attempts to inject philanthropy and conditions contrary to economy into public service. Every reason given when properly analyzed is an argument against municipal ownership.

13. "To protect municipal officers from temptation."

14. "To purify politics, raise the standard of municipal officers and secure honest administration of all public trusts."

15. "To compel citizens to take an interest in public affairs."

16. "To assist in raising the standard of living amongst the poorer classes by supplying them with public service at operating cost."

17. "To secure ownership by the people for the elevating effect on citizenship."

Crowded from the field of legitimate reason, the advocates have shown a talent for resourcefulness, ingenuity and sophistry worthy of a better cause. Has resourcefulness ever before been so dangerously strained, imagination more severely

taxed, ingenuity more atrociously prostituted, or truth more brutally crucified?

Matthew, 25th chapter, 21st verse, in the 20th century Bible is made to read: "Thou hast been *unfaithful* over a few things, I will make you ruler over many things." The Bible of our fathers said: "Thou hast been *faithful* over a few things, I will make you ruler over many things."

Municipal ownership is to be made an institution of charity, and the needy are to be determined by their political faith.

Citizens are to be compelled to neglect their own business to spy upon the conduct of municipal officers, or be robbed as punishment for their neglect of this unwillingly contracted public duty.

Municipal ownership is to raise the standard of living, and our mechanics shall become poets, painters and students of books on sociological subjects by authors whose arguments are created to bolster up previously expressed views born of prejudice and lack of knowledge.

Sarcasm and satire are seldom effective weapons, but when logic is spurned, truth rejected, and reason assassinated, no other effective means of protest is offered.

GENERAL SUMMARY.

To sum up, the reasons advocated for municipal ownership may be classed under three heads which, stated in the order of their importance, are (1st) economic, (2d) philanthropic, and (3d) sentimental.

The economic reasons are in general not well founded, are scarcely ever in accord with truth, and are at great variance with experience. The advocates assume they can operate a public service plant with equal or greater economy than can private enterprise. This has not been proven true, or at least has not been proven true in the majority of cases where municipal ownership has been tried. Admitting for the sake of argument that the city could either make a profit in the operation of a public utility plant or could sell at a less cost if satisfied with no profit, the advocacy of municipal ownership of public utilities on this score is open to some objections and is not thoroughly in accord with wisdom. If economy is

all that is to be sought, the city could enter into other business enterprises which, on the assumption that present operators' profits would either accrue to the city or be given to the consumer, would yield greater benefits to the consumer with less investment to the city and with less risk. Probably no other business involving the supply of commodities constantly required by the public yields such a small return on the investment as does the gas and electric business and these commodities absorb less of the public expenditures. Two to six dollars per annum per person for both public and private service will represent the total revenue of these two utilities combined. Why attempt to save a consumer one dollar on light when the city might save him four dollars on coal or ten dollars on groceries? We have already admitted that the city has one advantage over the private undertaking, viz., the securement of funds at a lower rate of interest. The average consumer pays from ten to twenty times as much house rent as he pays for light. As the ownership of tenement houses resolves itself largely into a question of interest rates, the city could, by putting the same amount of money into tenement houses, save the citizens at least ten to twenty dollars for every dollar they could save them on light; and probably the saving would be greatly in excess of this, assuming that the city's operation would be just as economical as private operation.

If municipal ownership is to be urged for philanthropic reasons, almost any other form of business enterprise which the city might choose to embark upon would offer greater opportunity to benefit the citizens than does the operation of public utility plants.

From a sentimental standpoint, the arguments advanced in favor of municipal ownership are generally prompted by prejudice, which to a large extent is entirely unwarranted. It is useless to maintain that the present system of corporation operation cannot be improved upon, but it is utterly absurd to attempt to tear down the whole system because it has not attained perfection. The whole argument in favor of municipal ownership is so pronouncedly in discord with justice as to be repugnant to every fair-minded man after careful consideration.

There are no dangers from corporation control which cannot be removed or restricted. If it is necessary to take control of public utility companies in order to protect municipal officers from temptation and to secure a higher standard of administration of public trusts, it is also necessary to assume control of the manufacture of baking powders, the manufacture of fire apparatus, the manufacture of paving material, and the manufacture of a thousand and one other commodities which have played an important role in the exposed corrupt practices in which public officers have indulged. To place corporations entirely and constantly in the hands of municipal officers leaves unlimited possibilities for corruption, but the dealings with corporations can be made of a periodic nature which must attract public attention and offer little or no opportunity for corruption. The making of burdensome provisions for the control of public corporations is what forces many corporations into politics. When you subject the future of an industry, involving the investment of several hundreds of thousands of dollars, to the whim of politicians who can disfranchise the undertaking at will, or who can impose such restrictions on its operation as to jeopardize the investment, or who can fix rates at a time when an election may demand the supply of funds from an outside source, you are putting into the hands of these municipal officers, whom the press chooses to term the worst foes of the public, the means by which they can compel corporations to share a goodly portion of their profits. It is therefore only natural, and what might be expected from prudent business men, that those whose property is thus jeopardized should sometimes attempt to elect men to these offices who will not yield to the temptation to which inexperienced lawmakers have exposed them. While trying to protect themselves from coercion and blackmail, it is not to be wondered at that corporations should go a step further and attempt to fill these offices with men who will not only not menace the interests of the corporation, but who will protect them.

This difficulty is not an insoluble problem. In passing laws for the control of corporations, do not make the regulation of these corporations subject to the whim of municipal officers,

but create some positive and fixed standard for their control. One factor which prevents absolute honesty in public office is the fact that no man is safe from assault in the fulfillment of his public duties, and this alone inspires dishonesty and deceit. The public distrusts municipal officers too much in general, and perhaps not enough in particular, and public opinion is seldom if ever correct in its measure of the interest or dishonesty of public officials. It is not my opinion that corruption is as general as the major portion of the public seems to believe, and I have had an excellent opportunity to study at close range many prominent politicians in different western cities. I have seen some of these men shamefully abused by newspapers, for personal or other reasons, when conscientiously trying to do justice to their public trust. The great element of danger in the proper discharge of a public trust is the fact that no man, or at least very few men, are honest enough to do what they know is right in the face of contrary public opinion; and how can municipal ownership succeed when those in charge do not do, or do not even pretend to do, that which they know is right and for the people's interest? I was once adversely interested in a burden imposed upon a city which was such a gigantic fraud as to almost jeopardize the future of that city. A sensational press, not wholly disinterested, had stirred up to a remarkable degree, public prejudice against a company with which I was connected. Some of the municipal officers were cognizant of the great injury being perpetrated on the city's future, and I appealed to one of them to exercise the prerogative of his office in protecting the city against the ill-advised obligation it was about to assume. This man told me that he fully recognized the injustice being done to the interests of the city and her citizens, but explained that, owing to public sentiment, he could not interfere. I asked him if he would allow the city's interests to be thus jeopardized while he remained silent, and his reply was that in the event he should do what he knew to be for the interests of the city, the public would believe that our company had bribed him to take this step. Here was a man whom I did not think could be bought or influenced to the slightest degree, and yet, rather than face personal censure or

suspicion, he would allow the city's interests to be jeopardized to any extent whatever.

The injustice of the recommendations of many municipal ownership advocates needs but to be pointed out to be appreciated by the public.

They hold that the municipal government has a right to condemn and purchase any public utility on the basis of the appraised valuation of the present worth of its physical property. This would often mean a purchase at a price much less than its cost to the present owners or original builders, and would always mean the direct confiscation of any value in excess of the original cost of the plant or its present physical valuation. As an example of the injustice and inequity of this policy, I will cite an example which I used in a public address five years ago. We will assume a town of say 10,000 people. Two investors come to the town, whom for convenience I will designate as A. and B. A. builds a street railway and B. invests in unimproved real estate. The town grows rapidly and prospers. A., by the nature of his investment, which is an operating property, must exert himself to secure its successful management, and incidentally, by building and operating a public utility, must contribute largely to the improvement and growth of the city, while B., owing to the nature of his investment, is practically free from all responsibility or worry. He can live in Europe or any other place he may choose. In the course of twenty years the properties of both A. and B. have increased enormously in value owing principally to the growth of the city. At the end of this twenty-year period, the public steps in and demands from A. that he shall turn over his property at its then physical valuation, claiming that any equity in excess of this valuation rightly belongs to the city. B. is not molested in the ownership of his property, and yet every dollar of increased valuation has been added without even contributory help from him. Which is most entitled to the so-called unearned increment of their respective properties, A. or B.? Does justice warrant confiscation of one man's property without molestation of the other's? Do you think A. or anyone else would have put his money into a public utility company could he have foreseen that the

successors of the public officers who solicited him to build his railroad for the benefit which would accrue to the city, would twenty years thereafter assert their assumed right to confiscate the increased valuation resulting from a twenty-year investment and twenty years of hard work, incessant risk and constant worry? Every other investor in the town is allowed to reap this profit unmolested, and nothing less than the assassination of justice could deny this right to A. I have purposely put this example in personal form to momentarily bridge the prejudice from which a corporation must suffer when appealing for justice; but for convenience let us assume that A. had not sufficient capital to undertake the building of this street railway, and he therefore associated himself with four other men of equally moderate means. Are these five men any less worthy of being entitled to justice simply because they individually possessed insufficient capital to undertake this enterprise alone? Would the injustice be any less because there were five men instead of one man, or would it in fact be any less if there were fifty men instead of one man? I think not, in spite of the general impression to the contrary.

It is only necessary to call attention to the fact that while there is generally a considerable value in these public utility companies in excess of their original cost, there is not a single city where there has not been some real estate which has had an appreciation in value very much in excess of the appreciation in value of any of these public utility plants. I think you will also agree with me that if A.'s equity is to be confiscated, B.'s equity should also be confiscated. But who has a better right to this equity than A. and B.? If this equity is to be confiscated in the interest of the public, the benefits should be equitably apportioned. Is it to go entirely to the taxpayer, or entirely to the light-user?

If other examples are demanded of the injustice of the position of municipal ownership advocates, I might cite the conditions which actually exist in a certain Western city. A certain body of public-spirited men got together in the early days of the art and organized an electric lighting company and built an electric lighting plant. Later this same body of men organized another company and built a refrigerating plant,

circulating the refrigerating medium through the streets in much the same way that gas is distributed. The electric lighting plant, after many years of trials and tribulations, has become a pronounced success. The refrigerating plant was a dismal failure and much money was lost. There has now developed a determination on the part of some of the citizens to confiscate the electric lighting plant at its physical valuation. The owners are to be shorn of their profit in the electric undertaking, but are of course allowed to pocket their loss on the refrigerating plant. If the city is going to demand the profit on one, the least it can do is to bear the loss on the other. Is it fair to confiscate the profit in the electric light plant when, should it have proven a failure, these owners would have been compelled to have borne the loss? Surely the commonest kind of manly fairness must prompt a negative answer.

Let us take another example which actually exists. A gas plant was built in the early days by a few enterprising men in a small Western city. Later some of the same men also built a district steam heating plant. The city has since had a wonderful growth, and the gas plant has become a valuable piece of property. The steam heating plant has proven a losing venture. The city has already taken the preliminary steps to condemn and purchase the gas property. Those engineering the scheme propose to confiscate the so-called unearned increment of the gas property and leave these same men to bear the loss on the steam heating plant alone.

While it is not probable, it is still perhaps possible to secure the direct conversion of heat energy into electrical energy on a commercial scale. Given such a condition, it would render the major portion of our present properties worthless. It is very easy to imagine a condition whereby the public would be planning to condemn and purchase our properties at its physical valuation and by right of might would compel our acceptance. While these condemnation proceedings are pending, the solution of how to transform heat energy to electrical energy is discovered and the valuation of our property shrinks accordingly. In this event it is certain that the public would step down and out and would courteously allow the present

owners to bear their loss alone. This is a kind of a "heads I win, tails you lose" proposition.

Municipal ownership cannot be brought about on the present plans of the advocates without doing grave injustice to the present owners of these properties. This is one of the reasons why I have said that this question demands fearless and determined treatment. I have absolute faith that the American people as a body will not willingly make themselves a party to any unjust act. My more apparent and better reason for recommending fearless and determined treatment is to enable us to appeal to the judgment of the public by demonstrating to them that the claims of the advocates are unwarranted by experience already gained and that municipal ownership means to the city poorer and more expensive service, with no profit in operations, and probably a heavy loss. The National Electric Light Association have given this subject much thought and study, and they are convinced that a thorough investigation of the municipally owned plants will demonstrate that the majority of them now in operation are rank failures and that ninety per cent. of all municipally owned plants (including the confessed failures which have already been abandoned) will be demonstrated to be or to have been failures. Would any practical man recommend embarking on a policy which has already been proven to be such a fallacy? The National Electric Light Association have demonstrated their faith in this proposition by offering to join the League of American Municipalities in an impartial investigation of the results secured in municipal plants, and as an evidence of good faith the former body tendered the latter body a certified check in the sum of $2,500 to cover their portion of the expenses of this investigation. They also stand ready to make this same proposition to any other body or to any individual or individuals who claim to have faith in the success of municipal ownership.

Municipal ownership, should it become general, would, owing to lack of personal interest, legal restrictions of management and unwarranted criticisms of managing officers, cast a blight on the progress of the lighting business, and instead of leading the world in this art America would lose supremacy.

The more experienced advocates of municipal ownership

know that to bear out their claims, they are unsafe in citing American examples and they must seek examples in foreign countries. While not admitting that municipal ownership is a success abroad, it is irritating and humiliating to find a class of American residents who prefer a foreign system to an American system, and who want us to adopt the policy of these decaying nations, even though this very policy may have caused the decay.

Advocacy of municipal ownership is largely prompted by dislike for all corporations, which has been greatly increased by the fancied danger to the people's interest arising from these recent and larger corporations commonly designated as trusts. These people forget that fixed natural economic laws demand operation on a huge scale and that American supremacy in the markets of the world is only possible by our present system. These so-called Americans who wish to tear down our present system may console themselves with the fact that foreigners should, and probably do, appreciate their efforts. The operation of our present system may not permit distribution of benefits to a fine-haired degree of accuracy, but there can be no doubt that all classes and all individuals receive some benefits.

Methods which have made America rich and powerful are good enough for me. Those who wish may take their example from those nations which are traveling toward the dark. This country is already in the lead and is still climbing, and should it ever cross the divide and start downward, I thank God I will not then be alive to see it. The fact that a few men, by merit or chance, get a bigger piece of pie than I do, will never prompt me to cry out against the institutions and methods which have enabled this nation to get a bigger piece of pie than other nations.

NOTES ON THE OPERATION OF LARGE CARBURETTED WATER GAS SETS.

Written for the Thirty-first Annual Meeting of the American Gas Light Association by W. Cullen Morris, M. E., Long Island City, N. Y.

In the last two or three years there have appeared in *The Journal of Gaslighting* several papers on the theory of water gas processes, extensive in their consideration of factors affecting the composition of the resulting gas. In nearly all these papers the effect of an excess of steam is discussed at some length, and without a more definite conclusion than that there is a proper rate of flow, possibly different for each type of apparatus, and that this rate is affected by the temperature of the fire.

Dr. J. Kramers, in his paper on "Water Gas Manufacture in Theory and Practice," after a rather lengthy consideration of the effect of an excess of steam, concludes, that:

"1. An endeavor must be made to obtain the highest possible temperature in the generator.

"2. One must try to have as little as possible undecomposed steam in the gas, not only because it carries off many calories, but because it may cause the proportion of carbonic acid to rise considerably, and the heat thereby liberated is of no advantage to the generator."

Drs. H. Stracke and R. Jahoda, in their discussion of the "Theory of the Water Gas Process," lay particular stress upon the rate of flow of the steam, and imply that Dr. Bunte, in his work, did not appreciate the effect that different rates of flow would have upon the resulting gas.

In the course of their paper, they write:

"1. That at a particular temperature, both the steam passing through undecomposed and the proportion of carbonic

acid in the gas largely increase with the increase in the rate of the steam, and, moreover, increase to a similar extent.

"2. That with a constant rate of flow of the steam, both the steam and the carbonic acid in the crude gas decrease with increase in the temperature.

"3. That at low temperatures the carbonic acid and steam in the crude gas can be reduced to a minimum by diminishing the rate of flow of the steam."

And in their summary they give the following table :

Rate of Flow of Steam.	Minute of Run at which observation was made.	Temperature of Generator ° C.	Temperature of effluent gas ° C.	Undecomposed Steam — Percentage of total.	Carbonic Acid Per Cent.	Efficiency of Run. Per cent. of maximum.	Total efficiency. Per cent. of maximum.
0.58	2	790	228	1.3	7.1	——	——
	5	788	207	2.7	4.6	69.0	54.5
	12	785	214	9.1	6.2	67.0	53.0
	20	778	221	21.8	8.9	60.5	47.0
	35	740	200	48.8	13.0	42.0	33.0
4.40	1	860	390	4.0	2.2	92.0	75.0
	3	850	390	10.0	2.7	91.0	74.0
	6	816	365	22.0	4.5	90.0	75.0
	9	810	365	24.0	6.6	88.0	73.5
	12	796	408	28.0	8.7	86.3	71.8
	16	775	415	45.5	11.4	83.5	71.0
7.50	1	——	530	——	2.7	——	——
	3	——	515	11.7	4.6	90.0	69.0
	6	——	490	27.4	9.6	88.0	70.5
	9	——	470	54.2	12.6	78.0	63.0
	12	——	470	62.1	15.6	73.0	59.0
8.10	1	——	515	——	3.4	——	——
	3	——	510	1.3	5.5	91.0	71.0
	6	——	500	19.7	11.2	88.0	70.0
	9	——	475	——	14.9	86.0	71.0
	12	——	470	47.9	17.3	82.0	68.0

13.00	1	——	470	7.6	3.4	92.0	73.5
	5	——	500	11.9	5.6	91.5	73.0
	6	——	500	32.1	9.0	92.0	71.5
13.40	1	900	470	14.3	5.0	91.5	72.5
	3	880	478	27.9	6.9	89.0	71.0
	6	830	475	48.9	9.4	84.0	67.5
	9	800	493	62.8	13.1	77.0	62.5
	12	780	492	69.6	13.9	74.0	60.0
17.00	1	——	600	8.1	2.6	91.0	69.0
	3	——	590	25.8	5.3	88.0	67.0
	6	——	560	48.5	11.8	81.0	62.0
	10	——	540	73.6	14.9	67.5	51.0
	12	——	530	76.5	15.2	65.0	51.0
21.20	1	945	680	8.6	4.4	90.5	70.5
	3	910	650	41.3	6.8	83.0	63.0
	6	865	620	48.6	8.7	81.0	61.5
	12	805	590	70.1	14.4	68.5	53.5
	16	780	——	77.6	17.6	61.5	47.0
21.30	1	——	680	——	2.1	——	——
	3	——	650	23.0	6.0	90.0	70.5
	6	——	620	63.3	11.8	72.5	54.0
	10	——	595	77.1	14.8	61.5	46.0

The researches of Harris, under the direction of Dr. Bunte, were tabulated as follows :

Temperature ° C	Composition of Gas Volumes per cent.			Water Vapor per cent.	
	H	C O	C O_2	Decomposed.	Undecomposed.
694	65.2	4.9	29.8	8.8	91.2
758	65.2	7.8	27.0	25.3	74.7
838	62.4	13.1	24.5	34.7	65.3
838	61.9	15.1	22.9	41.0	59.0
861	59.9	18.1	21.9	48.2	51.8
954	53.3	39.3	6.8	70.2	27.2
1010	48.8	49.7	1.5	94.0	6.0
1060	50.7	48.0	1.3	93.0	7.0
1127	50.9	48.5	0.6	99.4	0.6

If we take the table of Drs. Stracke and Jahoda and retabulate for percentages of carbonic acid in the neighborhood of six per cent., we obtain a table as follows :

Rate of Flow of Steam.	Minute of Run at which observation was made.	Temperature of Generators.	Undecomposed Steam. Per cent. of total.	Carbonic Acid per cent.
0.58	12	785	9.1	6.2
4.40	9	810	24.0	6.6
7.50	3	...	11.7	4.6
8.10	3	...	1.3	5.5
13.00	3	...	11.9	5.6
13.40	3	880	27.9	6.9
17.00	3	...	25.8	5.3
21.20	3	910	41.3	6.8
21.30	3	...	23.0	6.0

Considering this tabulation, we see that, with two exceptions, at the third minute of the run the carbonic acid is never in excess of 6.9 per cent., no matter what the excess of undecomposed steam may be. Also, there does not appear to be any special relation between the temperature and the amount of carbonic acid, nor does the rate of flow of the steam bear any definite relation to the amount of undecomposed steam, or, more particularly, the amount of carbonic acid.

This certainly appears strange, for surely the temperature of the fire must have some effect upon the quantity of steam decomposed.

That the rate should not have any great influence does not surprise me, as I do not see that, other than requiring an additional amount of heat to be supplied, why up to a certain point, it should have any appreciable effect.

If we consider Harris' results for six per cent. of carbonic acid, and also for the nearest temperature to that obtained by averaging the four cases in which the temperatures are given in the above and compare, we have :

Temperature ° C.	Undecomposed Steam, per cent.	Carbonic Acid per cent.	
954	27.2	6.8	(Harris)
838	62.2	23.7	
846	25.6	6.6	(Stracke & Jahoda)

A comparison that does not show any great agreement. Of course, the method of obtaining these was different, as different as laboratory work is from that of the manufactory ; but still, one would expect a closer agreement than this.

The frequent extensions of the plant at which I am stationed have prevented the devotion of much time to precise observation, but in the operation of our apparatus, daily records are made covering the grosser factors influencing the running of the carburetted water gas sets.

Recently there were installed at this works eight (8) carburetted water gas generators of the "double superheater" type having an internal diameter of nine (9) feet.

The new sets differed in their principal dimensions from the eleven (11) foot sets, that had been previously installed, as shown below :

		11 Ft. Sets.	12 Ft. Sets.
Generators,	O. D.	11 ft. 0 in.	12 ft. 0 in.
	I. D.	8 ft. 0 in.	9 ft. 0 in.
	Depth.	7 ft. 0 in.	7 ft. 0 in.
Carburetters,	O. D.	11 ft. 0 in.	12 ft. 0 in.
	I. D.	8 ft. 0 in.	9 ft. 0 in.
	Height	16 ft. 0 in.	18 ft. 8 in.
Superheaters,	O. D.	11 ft. 0 in.	12 ft. 0 in.
	I. D.	8 ft. 0 in.	9 ft. 0 in.
	Height	22 ft. 0 in.	24 ft. 3 in.

Naturally we were interested to learn if our anticipation in regard to these large sets would be realized. We had good reason to believe that they would equal in make and economy the eleven (11) foot sets, and it was with a great deal of impatience that we waited for the Summer falling off in demand to occur, so that we might operate the new sets by themselves and determine their capabilities.

The data was accumulated with the idea of determining the proper rate of flow of steam supply to the generators for producing the best working results. It is not always possible to maintain laboratory perfection in operating a large number of units, and when determining the conditions governing the

working of apparatus it is always well to experiment under the conditions that will exist in their every day use. The results that we will later consider were obtained under such conditions as would exist in every day practice, and no pretension is made that they are the best that could be obtained for this type of apparatus. No special precautions were taken to produce gilt edge results; each recorded test was continued until the results were characteristic of the particular conditions, and would, I believe, be reproduced upon the return to these conditions.

In starting a particular set of conditions instructions were given to the head gas-maker to alter so and so, in exactly the same manner as is frequently necessitated by a change in the character of the fuel, oil or other element entering into the process. As a consequence, it is not possible to state that the conditions were always precisely maintained.

All the results set forth were compiled from the daily reports, and, consequently, do not include any unusual or special observation such as might have been made had it entered the writer's mind that he should, at some later date, desire to incorporate them into a paper for this Association.

In making these rough tests there was another object besides that mentioned: a desire to demonstrate to our full satisfaction that we had not lost in economy or productive capacity by increasing the grate area over the eleven foot sets. Previous experience with one of the old eleven foot sets, in which we had enlarged the grate area and internal diameter by thinning the lining, had led us to expect at least as much from the new sets, both in fuel per one thousand cubic feet, and in make per square foot of grate area.

Before entering into a consideration of the results it would probably be well to briefly describe the method of operating the sets throughout the series of tests, so that a full understanding of the tabulated data may be obtained. Each machine consists of the regular type of United Gas Improvement Company's "Double Superheater Set," consisting of a generator, carburetter and superheater. The apparatus is provided with a mechanism for reversing the direction of the flow of gas

from the generator, and to this mechanism we have attached a device for effecting, at the same time that the gas flow is reversed, a reversal in direction of flow of the steam. Before the steam enters this device it must pass first through a globe valve opened by the gas-maker, and then through a plug cock set at a desired opening. This cock is provided with a pointer on the plug and a scale on the body, the position of the pointer showing on the scale the degrees that the cock is open. Between the valve and the cock there is attached a steam gauge, showing the pressure of the steam before entering the cock. By this device the quantity of steam supplied per minute can be determined, as the cock has been calibrated for several inlet pressures and openings.

The direction of the flow of the steam through the fire bed is reversed in each run, a part of each run being made with the steam first passing down through the fire and then finishing with the steam passing up through the fire bed. The blows are so regulated as to produce a proper heat in the fire and to raise the checker brick to a temperature sufficient for fixing the oil.

The fires are cleaned at the end of twelve (12) hours, and only the ash is removed. The refuse from the fire is screened and the small quantity of half-burned coal returned to the generators.

In comparing the old and new sets I have taken the best results obtained on the old sets with the same kind of fuel; but in considering this it must be borne in mind that the results were obtained in a different year, and the coal might not have been of the same character, possibly being mined from a different seam. I speak of this because the steam was, in this test, supplied under a different set of conditions from the best result obtained on the new sets. In all cases the actual oil results have been omitted, as they would only apply to the particular season of the year in which the tests were made.

The following table contains the data governing the conditions and the results obtained for each of the several methods of running:

TABLE NUMBER 1.

Results on 12 Foot Carburetted Water Gas Set.							11 ft. Sets
Case Number,	A	B	C	D	E	F	G
Velocity of Steam, lbs. per min.,	67	77	87	97	102	107	72
Steam Cock Opening, degrees,	75	75	75	75	75	75	67½
Steam Pressure, lbs.,	50	60	70	80	85	90	70
Length of Blow, minutes,	6.5	6.5	7	7	7	7.5	7
Length of Run, minutes,	8	8	8	8	8	8	8
Minutes Up,	3	4	4	4	4	4	4
Minutes Down,	5	4	4	4	4	4	4
Blast Pressure, inches,	18	18	18	18	18	18	20
Per 1000 Cu. ft. Generator Coal, lbs.,	33.12	36.14	33.28	33.19	32.73	34.22	33.3
Per 1000 Cu. ft. " Cinders, lbs.,	1.06	1.83	.82	.93	.75	.77	0.0
Per 1000 Cu. ft. Steam, lbs.,	19.84	24.19	24.87	26.65	27.94	30.31	24.03
Per Sq. ft. Grate per hr. Generator Coal, lbs.,	49.88	50.41	50.98	53.77	51.81	52.81	53.42
Per Sq. ft. Grate per hr. " Fuel, lbs.,	51.48	52.97	52.24	55.28	53.00	54.01	53.42
Per Sq. ft. Grate per hr. Steam, lbs.,	29.88	33.75	38.10	43.17	44.23	46.65	38.63
Per Sq. ft. Grate per hr. Make, Cu. ft.,	1506	1395	1532	1620	1583	1539	1608
Time between Cleans, hours,	12	12	12	12	12	12	12
Average time spent on Cleans, minutes,	72	104	75	69	62	62	69
Carbonic Acid, per cent.,	2.8	3	2.9	3.1	3.2	3.1	3.1
Length of Test, days,	7	3	5	10	10	3	5
Final condition of Fires,	Bad	Bad	Bad	Good	Good	Fair	Good
Remarks,	Time required to clean fires increased from 65 to 90 minutes, due to increasing clinkers.	Coal very dirty and small from much handling; thus reducing the make.	Make generally fell off, due to increasing clinkers and increasing time required to clean fires.	Condition generally easy to control.	Fire soft. Otherwise condition good.	Condition generally good. Fires tend to become too soft, causing loss of coal when cleaning.	Fires somewhat hard.

In comparing the tests it is assumed :

That a yield of 5.8 candles per gallon is a fair yearly average, with gas oil, for finished gas containing three per cent. of carbonic acid.

That one per cent. of carbonic acid will depreciate the candle power three-quarters of one candle, or that each increase or decrease of one per cent. in the quantity of carbonic acid present, over or below three per cent., would affect the oil required to the extent of three per cent., or would affect the cost of gas per thousand cubic feet to the extent of five-tenths of one cent (the cost of oil is taken at what would seem a fair average price), the desired candle power being twenty-five candles. The amount of oil required is not entirely governed by the quantity of carbonic acid present. Uniform and proper heats are necessary, and a condition that will produce this state is the most desirable.

Further, that the cost of one pound of steam supplied to the generators would be 0.0275 cents, made up of the following items :

Per pound of steam supplied :

Boiler Room Labor - - -	0.0070 cents.
Water - - - - -	0.0016 "
Coal - - - - - -	0.0182 "
Steam to Feed Pump - - -	0.0007 "
Total cost - - -	0.0275 "

That the cost of air required by the generators may be considered constant per thousand cubic feet of gas made, and, therefore, need not be taken into account.

That the cost of generator fuel is $5.00 per gross ton, and that the cost of the generator house labor required and affected in the considerations is as follows :

No. of Sets Running at one time.	Five.	Six.	Seven.
Gas-makers	10—$27.00	12—$32.40	13—$35.10
Stokers	6— 12.00	6— 12.00	6— 12.00
Coalmen	4— 8.00	4— 8.00	4— 8.00
Ashmen	4— 8.00	4— 8.00	4— 8.00
Per 24 hours	24—$55.00	26—$60.40	27—$63.10

Further, that thirteen millions (13,000,000) cubic feet is the desired daily make.

Considering this last assumption, it will be seen that to accomplish this make it will be necessary to consider each case separately and determine the number of generators necessary for producing this make.

Small repairs of various kinds, such as new oil sprays, etc., are required during the day, causing a small loss in the available running time of each machine. On these repairs the gas-makers can be employed to advantage, so that any delay not exceeding, say, in our case, six hours of the total running time, would not affect the cost per thousand directly chargeable to gas-making.

When the number of hours required is not over twelve hours, that required for an even number of generators, it will be assumed that an extra generator can be run during the cleaning periods; thus, not requiring an additional gas-maker, as the time taken on cleans with six generators will amount to at least twelve hours.

Examining each case with a view of running the least number of sets, and utilizing the gas-makers' time to the best advantage, we find that the desired amount, thirteen million cubic feet, could be manufactured as follows:

Case.	Number of hours running	Number of hours idle.	Number of Gas-makers required.		Number of Sets under Fire	Remarks.
			Day	Night		
A	135.9	8.1	6	5	6	(See Note 1.)
B	134.7	9.3	6	5	6	(See Notes 1 & 2)
C	133.5	10.5	6	5	6	
D	126.3	17.7	5	5	5	
E	129.1	14.9	5	5	5	
F	132.8	11.2	6	5	6	
G	160.7	7.3	7	7	7	

NOTE 1. It is very probable in this and the next case that the fires would become so hard, possibly all at one time, that it would be necessary to hold extra sets under fire. This point has not been taken account of in the discussion.

NOTE 2. It is hardly fair to consider this case as set forth in the test. The conditions producing the results were unusual, the coal that was used having been much handled and very dirty. In our consideration it has been assumed that for this case the results would be a mean between cases A and B, and that the carbonic acid would be the same as for case B, if all other conditions had been equal.

If we now tabulate from the foregoing data the costs for each case, we will obtain a set of figures from which we can, with limitations, determine which is the most economical. This has been done in Table No. 2.

COST IN CENTS PER 1000 CUBIC FEET.

TABLE NUMBER 2.	12 Foot Sets.						11 Foot Sets.
	A	B*	C	D	E	F	G
Generator house labor	0.44385	0.44385	0.44385	0.42308	0.42308	0.44385	0.48538
Cost of Steam	0.54560	0.61476	0.68393	0.72288	0.76835	0.83353	0.66083
†Additional Cost of Oil	0.10000	0.05000	0.05000	0.05000	0.10000	0.05000	0.05000
Generator Fuel	7.39238	7.41024	7.42810	7.40801	7.30534	7.63790	7.43256
Total	8.28183	8.41885	8.50588	8.60397	8.59677	8.96528	8.62877

* Assumed Results.

† In columns A, B and C this item is a negative quantity.

Other factors should enter into our consideration of these figures. I have before referred to the fact that other influences affect the quantity of oil required. I have frequently noticed that when changing from a lower to a higher rate of steam the amount of oil required was appreciably decreased. I can only explain this in one way :

That the cracking is accomplished to better advantage if some steam is present, probably by prevention of over cracking.

Then, again, cases A, B and C are difficult to maintain for a long period, and it was not easy to keep the heats in the fixing chambers uniform for these cases.

The advantage of a system of running which will produce the same results day after day is of paramount importance and cannot be stated in dollars and cents, and would not appear in our comparison of costs.

In comparing the economy of the 12 foot and 11 foot sets, the difference is in favor of the larger sets. The make per square foot of grate is virtually the same.

Considering the original outlay of capital: Case A, if possible to maintain, would require at least seven sets, case E six sets, and case G eight sets. If we assume wear and tear to be covered by fifteen per cent. of the original cost, we would have charges per thousand cubic feet as follows:

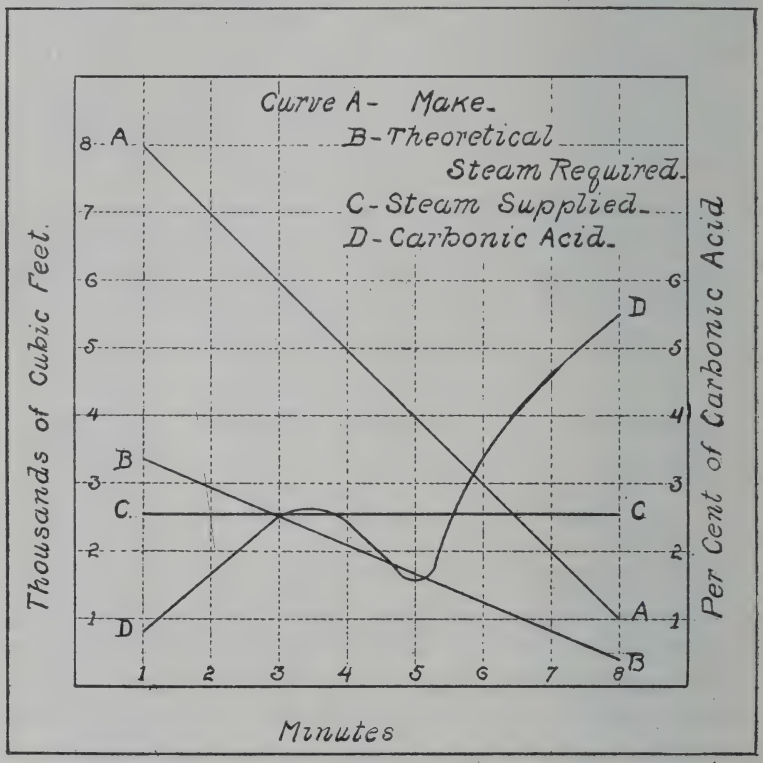
	Case A.	Case E.	Case G.
Previous cost -	8.282 cts.	8.597 cts.	8.629 cts.
Wear and tear -	0.420	0.360	0.401
New Total -	8.702 cts.	8.957 cts.	9.030 cts.

Still showing to the advantage of the larger sets.

Case A is considerably lower than case E; but I am free to confess that I believe, in fact, my experience has shown, that there is not the difference in oil results indicated by the figures, other factors, uniform heats, etc., affecting the results to a greater degree. Still, it is more than probable by changing some other factor, blast, time of cleaning fires, or depth of fire bed, that this low steam result could be maintained successfully.

Returning to a consideration of the effect of the rate of flow of the steam upon the amount of carbonic acid formed, the results obtained on this type of apparatus do not agree with the claims of the writers before referred to. In our case the mean percentage of carbonic acid is about three, or about five per cent. in the blue gas. The amounts of steam supplied vary from twenty-four to ninety per cent. excess, with no con-

siderable variation in the amount of carbonic acid formed,* and, as stated in the early part of this paper, I consider that the temperature of the fire bed is a greater factor than the rate of flow of the steam, within reasonable limits.



* Curves showing make, steam required, steam supplied, and carbonic acid, for each minute of a run. The steam required was determined from an analysis of the finished gas.

In Memoriam.

✠

"Now is done thy long day's work."

✠

ELMER B. KNIGHT,

Far Rockaway, N. Y.

Died June 17th, 1902.

JULIUS BUSS,

Milwaukee, Wis.

Died November 23d, 1902.

FREDERICK A. WELLES,

Jersey City, N. J.

Died December 16th, 1902.

WILLIAM K. PARK,

Philadelphia, Pa.

Died May 13th, 1903.

EUGENE VANDERPOOL,

Newark, N. J.

Died July 12th, 1903.

HENRY B. LEACH,

Taunton, Mass.

Died July 25th, 1903.

✠

"There is no Death! what seems so is transition."

ELMER B. KNIGHT.

BORN November 29th, 1850. DIED June 17th, 1902.

Elmer B. Knight was born at Gaysport, Pa., November 29th, 1850. His early education was obtained in the public schools of Hollidaysburg and Manayunk, but his attendance at school ended at the age of fifteen, when he was apprenticed to a brick mason.

After learning his trade he worked at it for a few years, and then finding that it was not to his liking he abandoned it. Through Prof. T. S. C. Lowe he became connected with the gas business, in which he remained until his death. After terms of service with A. O. Granger and the United Gas Improvement Co., he entered into partnership with Mr. Henry Steck, of Philadelphia, for the purpose of building gas works.

From building gas works he went to managing them, being for a time Superintendent of the Hagerstown (Md.) Gas Co. For nine years he was part owner and Superintendent of the Hempstead Gas and Electric Co., of Far Rockaway, N. Y. A few months before his death he disposed of his interest in this plant and retired from active business.

Unfortunately he was not permitted to long enjoy his freedom from business duties. Death came to him very suddenly on June 17th, 1902.

Mr. Knight was elected an active member of the Association at the meeting held in New York City, October 21st, 1891, at which time he was Superintendent of the Hagerstown Gas Co.

Although he left school when comparatively young he was always of a studious nature, acquiring much knowledge by persistent study and equipping himself fully for the business to which he devoted the best years of his life.

JULIUS BUSS.

BORN 1860. DIED November 23d, 1902.

Julius Buss was born in Dortmund, Germany, and died there November 23d, 1902.

In 1879 he entered the service of August Kloenne, the proprietor of a large gas-works construction business. After ten

years of work in this line in Germany Mr. Buss came to the United States as an employee of Mr. Fred. Bredel, who had established himself in a business of the same character and was introducing the Kloenne specialties. He remained with Mr. Bredel until compelled to return to Germany in search of health in September, 1902. The quest was fruitless, but the voyage permitted him to die at the home of his mother.

Mr. Buss was elected an associate member of the Association October 19th, 1892, and was also an associate member of the Western Gas Association.

Although not a regular attendant at the meetings of the American Association, Mr. Buss became acquainted with many of the members through his duties in supervising the erection of the benches and apparatus installed by his employer. Conscientious and painstaking, he was willing to work at any and all times except Saturday evening, which he set apart for recreation in the company of a few close friends of his own nationality. By them he is remembered as a pleasant comrade and true friend.

FREDERICK A. WELLES.

BORN January 31st, 1877. DIED December 16th, 1902.

Frederick A. Welles was born in Perkinsville, Vt., January 31st, 1877. His preparatory education was such as to fit him to enter, in 1894, Stevens Institute of Technology as a member of the class of 1898. During the four years' course he showed quite a little literary ability, contributing many articles to various scientific publications and being a member of the editorial staff of the "Stevens Indicator." He was at the same time an earnest student and was awarded, at graduation, a Priestley prize in Chemistry.

After working a few months at Cold Spring, N. Y., for J. B. and J. M. Cornell, Mr. Welles was employed by the United Gas Improvement Co., with which company he remained until his death. As he displayed capacity and ardor in scientific work he was selected to carry out many important investigations, among them being those in reference to the photometric value of the Edgerton Slot and Pentane lamp,

the results of which were reported to the Association by Mr. Rollin Norris. At a later date he was assigned to the actual operation of gas works, being stationed first at the Front St. works of the Essex and Hudson Gas Co., in Newark, N. J., and then at the Sixth St. works of the Hudson County Gas Co. in Jersey City, being Superintendent of the latter works at the time of his death.

He was elected a member of the Association October 15th, 1902, and gave promise of being an active and useful member.

WILLIAM K. PARK.

BORN October 19th, 1828. DIED May 13th, 1903.

William K. Park was born October 19th, 1828, in the old district of Northern Liberties, Philadelphia, Pa., in which city he spent his whole life.

When the time came for him to look out for himself he learned the umbrella trade. Later he was for a time an engineer at the United States Mint, and in 1869 he was chosen by the Gas Trust, the governing body of the gas works belonging to the city, to be Assistant to the then Chief Engineer, Joseph Manuel, his first duties in this position being the supervision of the work of improvement that was being carried on at the Point Breeze plant. In 1879 he was made Chief Engineer, succeeding Thomas H. Brown, who had succeeded Joseph Manuel. This position of Chief Engineer Mr. Park held until the city of Philadelphia leased its gas plant to the United Gas Improvement Co. in 1898, when he was made by that Company Consulting Engineer for the Philadelphia Gas Works.

As a young man he joined the then existing Volunteer Fire Department, and remained an active member of it until its disbandment with the advent of a paid department. He also took an active part in politics, and in the early seventies was elected to Select Council, the upper branch of the city legislature. His membership in this body continued through the year of the Centennial Exposition, and he served on the Committee of the Council in charge of this Exposition, in which he was very much interested.

Elected an active member of the Association October 21st, 1885, Chief Park, as he was called, was a regular attendant at its meetings, until failing health put travelling out of the question, and he was well known to all the older members.

One of his conspicuous traits was loyalty to his friends, and their appreciation of this loyalty was shown by their devotion to him during the latter days of his life, when he was more or less confined to the house. Although his health had been poor for some years, he was at his office two days before his death, his final illness being of short duration.

EUGENE VANDERPOOL.

BORN September 2d, 1844. DIED July 12th, 1903.

Eugene Vanderpool was born September 2d, 1844, in Newark, N. J., of which city his father was a prominent citizen, being Mayor in 1846 and 1847. He prepared for college in the schools of his native city and entered Princeton College, as it was then, as a member of the class of 1864. Graduating in that year he subsequently attended the Rensselaer Polytechnic Institute at Troy, N. Y., where he obtained the technical portion of his college education.

Upon leaving college he was employed for a short time by the Morris and Essex R. R. Company, and in 1866 entered the field of gas engineering as an employee of the Newark (N. J.) Gas Light Co. In 1867 he was made Engineer of the latter company and in 1871 became its President. Both of these offices he held until the consolidation, in 1895, of the Newark Gas Light Co. and the Citizens' Gas Light Co. into the Newark Gas Co. under the management of the stockholders of the Citizens' Co. As a trustee for the holders of the bonds of the Newark Gas Co., he remained, however, up to his death, in touch with the gas business which he had so long directed.

In addition to the positions that he held with the Newark Gas Light Co., Mr. Vanderpool was also a director of the Montclair (N. J.) Gas and Water Co. during the whole period of its corporate existence, and a director in the Morristown (N. J.) Gas Co. and the American Gas Co., of Phila-

delphia. He was, moreover, closely identified with the management of various financial institutions in Newark, being a director of the National Newark Banking Co., a director and member of the finance committee of the Mutual Benefit Life Insurance Co., and a trustee and, for a year or more previous to his death, the President of the Howard Savings Institution.

Appreciating fully the benefits to be derived from the interchange of the opinions and experiences of men engaged in the same profession, Mr. Vanderpool joined the Association at its second meeting. Always an active member in the full meaning of the term, he was elected President in 1884 and presided over the meeting held in 1885. He was also instrumental in founding the Society of Gas Lighting, of which he was Vice-President from 1884 to 1896, and President from 1896 until his death.

Possessing a technical education, he was heartily in favor of the educational work first started in 1896 in charge of the Committee on Education of this Association, and when, in 1898, it became necessary to raise a fund to carry on the work he was selected as one of the Permanent Trustees appointed to administer this fund. When the Board was organized he was elected Treasurer and continued in that position until his death.

Although a very prominent figure in the business and financial circles of Newark, he never sought any elective office in the city, but after retiring from active work in the gas business he accepted an appointment as one of the Essex County (N. J.) Park Commissioners and was soon made their Treasurer. His engineering experience, combined with his willingness to devote his attention to the duties of the position, made him a valuable member of the Board, and much of its success in providing a park system worthy of Essex County must be credited to him.

Although always easy of access to those who had any excuse at all for claiming his attention, Mr. Vanderpool was a reserved man and formed few intimate friendships. Among these few were the present Governor of New Jersey, and the Chief Justice of the Supreme Court of the same State. Those who, while

not privileged to belong to the inner circle of his friends, were yet more than acquaintances, always found him willing to help them in any way in his power, and felt that they could depend upon him at all times and under any circumstances, although there was little that they could do in return for his kindness.

Born to wealth and a position of high standing in the community, he recognized the duties associated with these privileges and throughout his life acted upon the principle *noblesse oblige*. Dignified in personal appearance, strong in character and a hard worker, he naturally assumed the leadership in every enterprise in which he was interested, and his death was a severe loss to his native city as well as to his associates, while the suddenness with which it came intensified the grief of his family. To himself it surely brought the reward promised to "good and faithful servants."

HENRY B. LEACH.

BORN April 18th, 1838. DIED July 25th, 1903.

Henry B. Leach was born April 18th, 1838, in Taunton, Mass., and received his education in the public schools of that city. His first business connections were not with the gas industry and it was not until he was over thirty years of age that, after having been bookkeeper in a furniture store, he entered the employment of the Taunton Gas Light Co., as Clerk, Collector and Bookkeeper. He had been with the company some years when the then Treasurer and Agent died and he was promoted to fill the vacancy thus made. The position was held until his death and grew very much in importance with the great increase in the business of the company which came largely through his efforts as its manager.

He was elected a member of the Association at the meeting held in Pittsburg, October 18th, 1882, and was a regular attendant at subsequent meetings. He was also an honorary member of the Western Gas Association and a member of the New England Association of Gas Engineers, the Guild of Gas Managers and the Society of Gas Lighting. If he

happened not to be present at any meeting of either of these associations the fact was noted and deplored.

In the hours not devoted to business he was active in Masonry and was well known to members of the order all over New England. He was also actively interested in the Bristol Club of Taunton.

Having been born and educated in Taunton, Mr. Leach had long been identified with the growth of that city and always had its best interests at heart. His position as manager of the gas company naturally made him a prominent citizen and his genial, hearty manner and kindly disposition made all with whom he came into contact his friends. The influence that he acquired from the working together of these two causes was always used wisely and towards the attainment of better public and social conditions. With this record his sudden death was a great blow to the community in which he lived, as well as to his fellow gasmen who were accustomed to foregather with him at the meetings of the various associations. To none of them can these meetings be, in the future, all that they were when he was present.

UNITED STATES PATENTS RELATING TO GAS.

ISSUED FROM OCTOBER 1, 1902, TO OCTOBER 1, 1903.

October 7, 1902.

710,446. INCANDESCENT GAS-LAMP. Louis D. Frenot and Alexandre Gimonet, Newark, N. J. Filed April 9, 1901. Serial No. 55,048.

710,483. INTERNAL-COMBUSTION ENGINE. Patrick F. Maccallum, Fairbank, Helensburgh, Scotland. Original application filed May 7, 1901. Serial No. 59,128. Divided and this application filed Feb. 13, 1902. Serial No. 93,953.

710,540. INCANDESCENT GAS-BURNER. George W. Thurnau, New York, N. Y., assignor to American Incandescent Lamp Company, a Corporation of New Jersey. Filed May 31, 1901. Serial No. 62,458.

710,559. ACETYLENE-GAS GENERATOR. Charles W. Beck, New York, N. Y., and William C. Homan, Meriden, Conn., assignors to Edward Miller & Company, Meriden, Conn., a Corporation of Connecticut, and the Acetylene Generator Manufacturing Company of West Virginia, New York, N. Y., a Corporation of West Virginia. Filed Dec. 13, 1900. Serial No. 39,589.

710,647. SPEED-REGULATOR FOR EXPLOSIVE-ENGINES. Louis W. Witry, Waterloo, Iowa. Filed June 11, 1901. Serial No. 64,125.

710,727. EXPLOSIVE-ENGINE. Walter G. Wilson, Westminster, England. Filed Nov. 1, 1900. Serial No. 35,168.

710,771. SPARKING DEVICE FOR EXPLOSIVE-ENGINES. Theodore S. Glover, East Norwalk, Conn., assignor of one-half to Cyrus E. Crabbe, Stamford, Conn. Filed April 15, 1901. Renewed April 16, 1902. Serial No. 103,201.

710,802. ELECTRIC GAS-LIGHTER. Arthur Radiguet, Paris, France, assignor to Henri de Thiersant and Hans Jacob Norballe, London, England. Filed Feb. 28, 1902. Serial No. 96,139.

710,824. INCANDESCENT IGNITER FOR EXPLOSIVE-ENGINES. Carl W. Weiss, New York, N. Y., assignor of one-half to August Mietz, New York, N. Y. Original application filed Nov. 10, 1898. Serial No. 696,017. Divided and this application filed April 14, 1902. Serial No. 102,739.

710,840. VALVE FOR GAS OR GASOLENE ENGINES. Alanson P. Brush, Detroit, Mich. Filed Oct. 4, 1900. Serial No. 31,991.

710,841. MIXING-VALVE FOR GAS OR GASOLENE-ENGINES. Alanson P. Brush, Detroit, Mich. Filed June 10, 1901. Renewed Sept. 11, 1902. Serial No. 122,961.

710,874. ACETYLENE-GAS GENERATOR. William J. Loyer, San Marcos, Texas. Filed April 11, 1902. Serial No. 102,398.

710,911. GAS-ENGINE CYLINDER. Hermann E. Ebbs, Nuremburg, Germany, assignor to Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A. G., Nuremburg, Germany. Filed May 29, 1902. Serial No. 109,462.

October 14.

711,010. GAS-FURNACE. Thomas P. Shaw and John Fee, Montreal, Canada, assignors to the Gas Appliance Manufacturing Company, Limited, Montreal, Canada. Filed Nov. 26, 1900. Serial No. 37,843.

711,113. ATTACHMENT FOR GAS-COCKS. Alfred E. Kraeger, San Francisco, Cal. Filed Jan. 7, 1902. Serial No. 88,762.

711,235. GAS-ENGINE. Edward G. Shortt, Carthage, N. Y. Filed Oct. 5, 1901. Serial No. 77,706.

711,268. RETORT COKE-OVEN. John F. Wilcox and Dietrich E. Wagener, Cleveland, Ohio, assignors to Retort Coke Oven Company, Cleveland, Ohio, a Corporation of Ohio. Filed Jan. 2, 1902. Serial No. 87,992.

711,321. INCANDESCENT BURNER. Thomas M. Jamison, Memphis, Tenn. Filed March 1, 1902. Serial No. 96,291.

711,346. ACETYLENE-GAS GENERATOR. Pearl P. Reynolds and Jerry J. Reynolds, Laporte, Texas. Filed April 3, 1902. Serial No. 101,250.

711,389. GAS-STOVE. Hilliary Eldridge, Memphis, Tenn. Filed Dec. 7, 1901. Serial No. 85,078.

711,454. GAS-ENGINE. William J. Wright, Pittsburg, Pa., assignor of thirteen thirty-seconds to John F. McKibben, J. W. Lee and Fred J. Galloway, Pittsburg, Pa. Filed July 16, 1900. Serial No. 23,709.

October 21.

711,628. EXPLOSIVE-ENGINE. James F. Hill, Fleetwood, Pa. Filed June 12, 1901. Serial No. 64,227.

711,652. SPARKING MECHANISM FOR GAS-ENGINES. Ernest S. Bowen, Auburn, N. Y., assignor of one-half to Walter L. Fay, Auburn, N. Y. Filed July 5, 1901. Serial No. 67,108.

711,904. APPARATUS FOR THE MANUFACTURE OF COKE AND THE RECOVERY OF GASES THEREFROM. Thaddeus S. C. Lowe, Pasadena, Cal. Filed Aug. 12, 1901. Serial No. 71,751.

711,905. PROCESS OF MANUFACTURING COKE. Thaddeus S. C. Lowe, Los Angeles, Cal. Original application filed July 12, 1901. Serial No. 71,751. Divided and this application filed Feb. 25, 1902. Serial No. 95,498.

October 28.

712,067. Explosive-Engine. Charles E. Inglis, Cambridge, England. Filed April 16, 1902. Serial No. 103,409.

712,116. Acetylene-Gas Apparatus. Eugene Bournonville, Jersey City, N. J. Filed April 4, 1900. Serial No. 11,451.

712,117. Acetylene-Gas Apparatus. Eugene Bournonville, Jersey City, N. J. Filed April 4, 1900. Serial No. 11,452.

712,130. Incandescent Burner-Head. Thomas Gordon, Philadelphia, Pa., assignor to Gordon Plenum Light Co., Camden, N. J., a Corporation of New Jersey. Filed Dec. 17, 1901. Serial No. 86,197.

712,156. Gas-Lighting Device. Angelo Simonini, Brooklyn, N. Y. Filed Feb. 15, 1900. Serial No. 5,369.

712,171. Valve Mechanism for Explosive-Engines. George J. Altham, Fall River, Mass. Filed Jan. 3, 1900. Serial No. 271.

712,393. Gas-Motor. Leon A. C. Letombe, Paris, France. Filed June 1, 1901. Serial No. 62,696.

November 4.

712,474. Acetylene-Gas Generator. Davis Barnard, Bakersfield, Cal., assignor to Dave Barnard & Co., Bakersfield, Cal. Filed Feb. 19, 1902. Serial No. 94,776.

712,731. Incandescent Gas-Burner. Eugen Seiler, Berlin, Germany. Filed April 14, 1902. Serial No. 102,829.

712,791. Muffler for Internal-Combustion Engines. Carl C. Hedstrom, Portland, Conn., assignor to George M. Hendee, Springfield, Mass. Filed Oct. 28, 1901. Serial No. 80,192.

712,805. Explosive-Engine. Whitcomb L. Judson, Chicago, Ill. Filed April 25, 1901. Renewed July 3, 1902. Serial No. 114,272.

712,823. Gas-Lamp. Riverius Marsh, New Brunswick, N. J., assignor to George W. Glaentzer, New York, N. Y. Filed Sept. 19, 1898. Serial No. 691,402.

712,911. Coin-Freed Apparatus for Delivering Gas. William Cox, London, England, assignor of one-half to George Glover & Company, Limited, London, England. Filed Dec. 17, 1901. Serial No. 86,273.

712,929. Valve for Internal-Combustion Engines. Carl O. Hedstrom, Portland, Conn., assignor to George M. Hendee, Springfield, Mass. Filed Oct. 28, 1901. Serial No. 80,191.

712,940. Acetylene-Gas Generator. Richard Klinger, Gumpoldskirchen, near Vienna, Austria-Hungary. Filed June 7, 1902. Serial No. 110,647.

713,031. Apparatus for Automatically Lighting or Extinguishing Gas-Lamps. Thomas F. Westenholz, Hellerup, near Copenhagen, Denmark. Filed June 26, 1902. Serial No. 113,304.

November 11.

713,093. Gas Regulator. George H. Gregory, New York, N. Y. Filed Nov. 19, 1901. Serial No. 82,821.

713,147. Internal-Combustion Engine. William M. Power, Montclair, N. J., assignor to Pan-American Motor Company, New York, N. Y., a Corporation of New Jersey. Filed Dec. 27, 1900. Serial No. 41,255.

713,194. Sparking Mechanism for Gas or Gasolene Engines. James E. Bean (by judicial change of name now Edward Bean Parkhurst), Milwaukee, Wis. Filed Oct. 16, 1901. Serial No. 78,782.

713,223. Acetylene-Gas Generator. Fremont L. Irish, Auburn, Me., assignor of one-half to Arthur D. Hall, Linwood B. Jones and Edward R. Jones, Winthrop, Me. Filed Oct. 23, 1901. Serial No. 79,638.

713,291. Acetylene-Gas Generator. Tyrrell H. Duncombe, St. Thomas, Canada. Filed May 2, 1902. Serial No. 105,664.

713,303. Acetylene-Gas Generator. Henry Henley, and Henry H. Henley, Bloomington, Ind. Filed March 6, 1902. Serial No. 96,954.

713,314. Gas-Burner of Bunsen Type for Illuminating Purposes and for Heating. Pierre Lamure and Pierre E. Yège, Bois Colombes, France. Filed July 1, 1902. Serial No. 113,944.

713,332. Gas Engine. John McCoy, Indianapolis, Ind., assignor of one-half to Robert E. Poindexter, Indianapolis, Ind. Filed Sept. 11, 1901. Serial No. 75,046.

713,353. Acetylene-Gas Generator. George G. Smith, Florence, Italy. Filed May 28, 1901. Serial No. 62,188.

713,354. Means for Storing and Distributing Gas. George G. Smith, Florence, Italy. Filed Dec. 12, 1901. Serial No. 85,548.

713,366. Internal-Combustion Engine. Henning F. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed Feb. 3, 1900. Serial No. 3,843.

713,367. Internal-Combustion Engine. Henning F. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed March 21, 1900. Serial No. 9,530.

713,449. Gas-Burner. William F. Keiser, Columbus, Ohio. Filed April 7, 1902. Serial No. 101,625.

713,460. Regenerative Gas-Lamp. Thaddeus S. Leese, Bellview, Pa. Filed July 5, 1902. Serial No. 114,439.

713,496. Gas-Pressure Regulator. Frank J. Root, Binghamton, N. Y. Filed June 24, 1901. Serial No. 65,745.

713,536. Exhaust-Pipe Muffler for Gas or Other Engines. John L. Tobias and Charles J. Tobias, Chicago, Ill. Filed Oct. 11, 1901. Serial No. 78,353.

November 18.

713,632. Acetylene-Gas Burner. Raphael Granjon and Edouard Isnard, Marseilles, France. Filed Sept. 3, 1902. Serial No. 74,189.

713,640. Acetylene-Gas Generator. William C. Homan, Meriden, Conn. Filed Feb. 19, 1902. Serial No. 94,739.

713,647. Gas-Producer. William T. Kelly, Bellaire, Ohio. Filed Jan. 25, 1901. Serial No. 44,698.

713,658. Acetylene-Gas Generator. Cyrus W. Mackenzie, Waverly, Ind. Filed May 17, 1902. Serial No. 107,818.

713,701. Incandescent Gas-Burner. Victor H. Slinack, Philadelphia, Pa., assignor to Pennsylvania Globe Gas Light Company, Philadelphia, Pa., a Corporation of Pennsylvania. Filed July 5, 1902. Serial No. 114,503.

713,768. High-Pressure Burner for Incandescent Lamps. James Keith and George Keith, London, England. Filed June 24, 1902. Serial No. 113,011.

713,792. Explosive-Engine. John A. Ostenberg, Westminster Station, Vt., assignor to Frederick M. Gilbert, Walpole, N. H. Filed June 1, 1897. Serial No. 638,941.

713,793. Explosive-Engine. John A. Ostenberg, San José, Cal., assignor to Frederick M. Gilbert, Walpole, N. H. Original application filed July 14, 1899. Serial No. 723,775. Divided and this application filed Jan. 21, 1901. Serial No. 44,120.

713,856. Gas-Regulator. Melvin D. Compton, East Orange, N. J. Filed March 27, 1902. Serial No. 100,225.

713,860. Exhaust-Valve for Internal-Combustion Motors. William J. Crossley, Manchester, and James Atkinson, Marple, England. Filed Feb. 15, 1900. Serial No. 5,326.

714,008. Gas-Producer. Joseph A. Mitchell, Brooklyn, N. Y. Filed Jan. 28, 1902. Serial No. 91,596.

714,023. Safety Gas-Burner. George L. Palmer, Providence, R. I., assignor of two-thirds to Thomas M. Loftus and Archer W. Lang, Providence, R. I. Filed Feb. 21, 1902. Serial No. 95,034.

714,049. Sparker for Gas-Engines. Louis B. Smyser, Newark, N. J., assignor to Ferdinand E. Canda, New York, N. Y. Filed Jan. 29, 1900. Serial No. 3,068.

714,080. Exhaust-Condenser for Explosive Motors or Engines. Robert Whitson, Auckland, New Zealand. Filed March 20, 1902. Serial No. 99,183.

714,103. Burner. Sterling Elliott, Boston, Mass. Filed Dec. 29, 1899. Serial No. 741,996.

November 25.

714,125. Acetylene-Gas Generator. Edmund R. Angell, Derry, N. H. Filed Nov. 3, 1899. Serial No. 735,731.

714,162. Safety Gas-Burner. Louis F. Ducker, Boston, Mass., assignor to Ducker Automatic Gas Cut-off Company, Augusta, Me. Filed June 18, 1902. Serial No. 112,121.

714,180. Internal-Combustion Engine. Clark Hendricks, Riverside, Cal. Filed Dec. 11, 1901. Serial No. 85,512.

714,238. Acetylene-Gas Generator. Nils A. Renstrom, Omaha, Neb. Filed Jan. 7, 1902. Serial No. 88,773.

714,265. Safety by-Pass Device for Gas-Burners. Johann Vaillant, Remscheid, Germany. Filed Nov. 5, 1901. Serial No. 81,198.

714,318. Acetylene-Gas Generator. Frank M. Moore, Providence, R. I. Filed Feb. 13, 1902. Serial No. 93,925.

714,319. Acetylene-Gas Generator. Frank M. Moore, Providence, R. I., assignor of five-sixths to Burdette J. White, Westfield, Mass., and Charles Edward Merrill, Providence, R. I. Filed Feb. 13, 1902. Serial No. 93,926.

714,352. Combined Hot-Air and Gas Engine. Charles A. Anderson, Erick A. Erickson, and John Wickstrom, Chicago, Ill., assignors to Chicago Motocycle Company, Chicago, Ill., a Corporation of Illinois. Filed March 28, 1900. Serial No. 10,570.

714,353. Combination Hot-Air and Gas Engine. Charles A. Anderson, Erick A. Erickson, and John Wickstrom, Chicago, Ill., assignors to Chicago Motocycle Company, Chicago, Ill., a Corporation of Illinois. Filed Dec. 18, 1901. Serial No. 86,433.

714,443. Incandescent Gas-Lamp. Tom Brabson, Brooklyn, N. Y., assignor to Brabson Lamp and Manufacturing Company, a Corporation of New York. Filed April 25, 1901. Serial No. 57,477.

714,444. Gas-Lamp. Tom Brabson, Brooklyn, N. Y., assignor to Brabson Lamp and Manufacturing Company, Brooklyn, N. Y., a Corporation of New York. Filed Dec. 18, 1901. Serial No. 86,380.

714,454. Adjustable Gas-Check. Melvin D. Compton, New York, N. Y., assignor to Ball Check Light Company, New York, N. Y., a Corporation of New Jersey, Filed April 24, 1902. Serial No. 104,436.

714,490. Acetylene-Gas Generator. Henry Kinsey, George Challenger, and John H. Nott, Swansea, England. Filed Dec. 31, 1901. Serial No. 87,924.

714,492. Explosive-Engine. François Lagoutte, Asnières, France. Filed June 26, 1900. Serial No. 21,680.

December 2.

714,799. Gas-Engine. Joseph Hirst, New London, Conn. Filed Oct. 19, 1901. Serial No. 79,266.

714,853. Gas or Vapor Engine. Francis G. Bates and Benjamin A. Williams, Philadelphia, Pa. Filed July 13, 1899. Serial No. 723,682.

714,929. Acetylene-Gas Generator. Walter S. May, Clifton, Ariz. Filed Feb. 28, 1902. Serial No. 96,118.

715,004. Apparatus for Discharging Retorts. Leon Bertrand, Paris, France. Filed Feb. 5, 1902. Serial No. 92,731.

715,008. Steam Explosive-Engine. Charles A. Braden, Butler, Pa., assignor to the Braden Gas Engine Company, a Corporation of West Virginia. Filed Oct. 19, 1898. Serial No. 694,035.

715,035. Gas-Burner Tip. Edward Downey, New York, N. Y. Filed Jan. 14, 1902. Serial No. 89,671.

715,144. Gas-Producer. John Radcliffe, Wrexham, England. Filed Aug. 12, 1901. Serial No. 71,801.

715,150. Valve-Gear for Explosive-Engines. William J. Robb, Portadown, Ireland. Filed Jan. 2, 1902. Serial No. 88,160.

715,196. Sparking Igniter for Explosive-Engines. Chauncey C. Chamberlain, Ionia, Mich. Filed Dec. 12, 1901. Serial No. 85,661.

715,208. Gas-Engine. Joseph Lizotte, Quincy, Mass., assignor of one-half to Mellen N. Bray, Boston, Mass. Filed Dec. 11, 1901. Serial No. 85,441.

715,218. Process of Generating Water-Gas. Hugo Strache, Vienna, Austria-Hungary. Original application filed Oct. 31, 1900. Serial No. 35,008. Divided and this application filed Oct. 22, 1901. Serial No. 79,547.

December 9.

715,310. Gas-Producer. Martin Van Buren Smith, Philadelphia, Pa., assignor, by mesne assignments, to the American Stoker Company, a Corporation of New York. Filed Nov. 23, 1898. Serial No. 697,235.

715,311. Process of Generating Producer-Gas. Martin Van Buren Smith, New York, N. Y., assignor to the American Stoker Company, New York, N. Y., a Corporation of New York. Filed Nov. 18, 1901. Serial No. 82,665.

715,564. Gas-Meter. Jean R. Dupoy, Paris, France. Filed April 24, 1901. Serial No. 57,267.

December 16.

715,800. Air and Gas Mixer. Charles W. Hinman, Boston, Mass. Filed April 15, 1902. Serial No. 103,018.

715,801. Gas or Vapor Lamp. Otto C. Hoffmann, Chicago, Ill., assignor to Frank R. Greene, Chicago, Ill. Filed Dec. 19, 1900. Serial No. 40,415.

716,069. Explosion-Motor. Julien P. E. Liet, Paris, France. Filed Sept. 23, 1901. Serial No. 76,173.

716,119. Automatic Gas Cut-Off. Alexander M. Shough, South Charleston, Ohio. Filed May 26, 1902. Serial No. 108,938.

716,153. Acetylene-Gas Burner. Sern P. Watt, Morgan Park, Ill., assignor to Hine-Watt Manufacturing Company, Chicago, Ill., a Corporation of Illinois. Filed Jan. 3, 1902. Serial No. 88,309.

716,176. Gas-Burner. Adolf Beler, Pittsburg, Pa., assignor of two fifths to Charles H. Parsons, Jenifer, Ala., and Fred Hartley, Pittsburg, Pa. Filed Sept. 10, 1902. Serial No. 122,879.

716,277. Gas-Furnace. Edward P. Reichhelm, Bayonne, N. J., assignor to American Gas Furnace Company, Elizabeth, N. J., a Corporation of New Jersey. Filed Aug. 4, 1902. Serial No. 118,214.

December 23.

716,420. Apparatus for Regulating the Supply of Combustible Vapor or Gas to Burners. William Hooker, Woodside, England. Filed Jan. 18, 1902. Serial No. 90,280.

716,455. Method of Producing Gas from Peat. Leonard L. Merrifield, Toronto, Canada, assignor to Edwin James Checkley and Economical Gas Apparatus Construction Company, Limited, Toronto, Canada, a Corporation of Canada. Filed June 24, 1901. Renewed Nov. 21, 1902. Serial No. 132,297.

716,488. Acetylene-Gas Generator. Flavel Simonson, Sterling, Ill. Filed May 9, 1898. Serial No. 680,237.

716,556. Acetylene-Gas Generator. Swan M. Klarquist, Minneapolis, Minn. Filed Feb. 5, 1900. Serial No. 3,978.

716,563. Acetylene-Gas Generator. David N. Long, Buffalo, N. Y., assignor to Frederick C. M. Lautz, Buffalo, N. Y. Filed Dec. 20, 1900. Serial No. 40,481.

716,569. Acetylene-Gas Generator. Eugene Moreau, New York, N.Y., assignor to Britelite Lamp Company, New York, N. Y., a Corporation of New York. Filed Dec. 26, 1901. Serial No. 87,269.

716,570. Acetylene-Gas Generator. Eugene Moreau, New York, N.Y., assignor to Britelite Lamp Company, New York, N. Y., a Corporation of New York. Filed Dec. 26, 1901. Serial No. 87,270.

716,615. Explosive-Engine. Benjamin F. Bain, New Brighton, Pa. Filed Sept. 28, 1899. Serial No. 731,969.

716,641. Gas-Main Stopper. Robert D. Leech, New York, N. Y. Filed April 9, 1902. Serial No. 102,004.

716,757. Gas-Purifier. Ward J. Renwick and Joseph Heaton, Auburn, Me. Filed Feb. 25, 1902. Serial No. 95,638.

716,792. Gas-Engine. Francis E. Vaughn and Marion E. Vaughn, Pendleton, Ind. Filed June 29, 1901. Serial No. 66,467.

716,796. Gasometer. John W. Weeks, Providence, R. I., assignor to the Universal Acetylene Company, Providence, R. I., a Corporation of Rhode Island. Filed March 17, 1902. Serial No. 98,531.

716,803. Process of Purifying Gas. Edward Zahm and John A. Just, Syracuse, N. Y. Filed April 10, 1900. Renewed July 29, 1902. Serial No. 117,456.

December 30.

716,855. Gas-Igniter. Hugo Bergner, Frankfort-on-the-Main, Germany. Filed Aug. 16, 1902. Serial No. 119,955.

716,883. Acetylene-Gas Generator. John D. Forsyth, Stouffville, Canada. Filed Aug. 28, 1901. Serial No. 73,521.

716,916. Cut-off Valve for Gas-Pipes. Hiram V. Malcott and Charles K. Tuggle, Columbus, Ohio, assignors by direct and mesne assignments, to the Buckeye Safety Gas Valve Company, Columbus, Ohio, a Corporation. Filed April 28, 1902. Serial No. 104,976.

716,933. Acetylene-Gas Generator. Algernon S. Phelps, Jr., Chicago, Ill. Filed March 10, 1902. Serial No. 97,452.

716,964. Gas-Burner. Salmon Traubel, Hamburg, Germany, assignor to Hanseatische Acetylen-Gasindustrie Aktiengesellschaft, Hamburg, Germany, a Firm. Filed May 14, 1902. Serial No. 107,308.

717,000. Internal-Combustion Engine or Motor. Charles E. Henriod, Neuilly-sur-Seine, France. Filed Nov. 9, 1898. Serial No. 695,971.

717,221. Acetylene-Gas Generator. George E. La Cell, Lakota, N.D. Filed Sept. 2, 1902. Serial No. 121,819.

717,266. Gas-Producer. Royal C. Peabody, Brooklyn, N. Y. Filed Oct. 25, 1901. Serial No. 79,890.

717,334. Gas-Retort-Charging Apparatus. Gaston A. Bronder, Brooklyn, N. Y. Filed Jan. 18, 1902. Serial No. 90,306.

717,466. Electrical Igniter for Gas-Engines. Elliott J. Stoddard, Detroit, Mich., assignor to Charles F. Burton, trustee, Detroit, Mich. Filed Oct. 10, 1901. Serial No. 78,165.

717,482. Gas Incandescent Lamp. David S. Williams, Philadelphia, Pa., assignor of one-half to George S. Gassner, Philadelphia, Pa. Filed July 18, 1902. Serial No. 116,028.

717,483. Gas Incandescent Lamp. David S. Williams, Philadelphia, Pa., assignor of one-half to George S. Gassner, Philadelphia, Pa. Filed Aug. 2, 1902. Serial No. 118,050.

717,508. Governor for Explosive-Engines. Harry H. Segner and Charles B. Segner, Hagerstown, Md. Filed Sept. 13, 1901. Serial No. 75,245.

January 6, 1903.

717,535. Acetylene-Burner. John W. Bray, Leeds, England. Filed May 27, 1902. Serial No. 109,187.

717,575. Apparatus for Charging Inclined Retorts. Walter R. Herring, Edinburgh, Scotland. Filed July 14, 1902. Serial No. 115,486.

717,661. Acetylene-Gas Generator. Juan de Dios Tejada, Havana, Cuba. Filed Aug. 12, 1901. Serial No. 71,803.

717,747. Gas-Burner. Alfred H. Humphrey, Kalamazoo, Mich. Filed April 4, 1901. Serial No. 54,271.

717,832. Burner for Gas-Heaters. William E. Fitch, Louisville, Ky. Filed Nov. 10, 1898. Serial No. 696,038.

717,866. Gas-Burner. John Kelly, Chicago, Ill. Filed Sept. 29, 1902. Serial No. 125,203.

717,902. Electric Igniting Device for Internal Combustion Engines. Frank R McMullin, Highland Park, Ill., assignor to McMullin Motive Power and Construction Company, a Corporation of Illinois. Filed Feb. 7, 1902. Serial No. 93,104.

717,904. Thermal Gas-Valve. William C. Norton, Salem, Mass. Filed April 15, 1902. Serial No. 103,013.

717,990. Valve-Seat for Explosive-Engines. Winfred M. Harvey, Denver, Colo. Filed Aug. 18, 1902. Serial No. 120,005.

718,064. Valve-Gear For Gas-Engines. John C. White, Decatur, Ill., assignor to William L. Oakes, Decatur, Ill. Filed March 26, 1902. Serial No. 100,133.

January 13.

718,131. Muffler for Gas or Gasolene Engines. Joseph F. Kurtis, Springfield, and Herman F. Miller, Dayton, Ohio, assignors to George J. Ihrig and Ernest C. Ihrig, Springfield, Ohio. Filed July 21, 1902. Serial No. 116,329.

718,223. Loop for Incandescent Lamp-Mantles. Charles Simon and Isaac Eisler, New York, N. Y. Filed April 3, 1902. Serial No. 101,182.

718,299. Valve for Gas-Engines. Edwin E. Arnold, Pittsburg, Pa., assignor to the Westinghouse Machine Co., a Corporation of Pennsylvania. Filed May 22, 1902. Serial No. 108,541.

718,334. Igniter Apparatus for Gas-Engines. William P. Flint, Pittsburg, Pa., assignor to the Westinghouse Machine Co., a Corporation of Pennsylvania. Filed June 26, 1902. Serial No. 113,374.

718,472. Gas and Air Mixer. John F. W. Jost, Philadelphia, Pa., assignor to Welsbach Light Co., Gloucester City, N. J., a Corporation of New Jersey. Filed Oct. 2, 1900. Renewed May 31, 1902. Serial No. 109,786.

718,481. Internal-Combustion Engine. Walter Langdon-Davies and Alfred Soames, County of Surrey, England. Filed June 27, 1902. Serial No. 113,475.

718,482. Cooling Means for Explosive-Engines. Fred A. Law, Hartford, Conn., assignor by mesne assignments, to Morton Trust Company, trustee, a Corporation of New York. Filed June 26, 1899. Serial No. 721,882.

718,511. Explosion-Engine. John A. Ostenberg, Westminster Station, Vt., assignor to Frederick M. Gilbert, Walpole, N. H. Filed July 14, 1899. Serial No. 723,775.

718,532. Incandescent Gas-Burner. Charles Scott-Snell, London, England. Filed Feb. 11, 1902. Serial No. 93,586.

718,552. Mixing Device for Explosive-Engines. Henning F. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed Dec. 17, 1898. Serial No. 699,577.

718,574. Starting-Valve for Explosive-Engines. Harry M. McCall, Pittsburg, Pa., assignor to Pittsburg Gas Engine Company, Pittsburg, Pa. Filed Feb. 6, 1902. Serial No. 92,806.

718,592. Gas-Governor. John Zander, Chicago, Ill. Filed Jan. 9, 1902. Serial No. 89,019.

January 20.

718,658. Gas-Engine. Peter Robertson and Christ Matson, Racine, Wis. Filed July 29, 1901. Serial No. 70,064.

718,826. Gas-Meter. Harry C. Dick, Philadelphia, Pa., and Samuel A. Ehrenzeller, Westville, N. J. Filed Jan. 30, 1900. Serial No. 3,311.

718,884. Method of Producing Gas. John F. Stacey, Nashville, Tenn., assignor of one-half to Thomas E. Matthews, Nashville, Tenn. Filed Jan. 4, 1902. Serial No. 88,427.

718,887. Process of Making Gas. Benjamin Talbot, Leeds, England. Filed May 6, 1902. Serial No. 106,925.

718,933. Explosive-Engine. Hobert J. Hurd, Bridgeport, Conn., assignor to the Acme Oil Engine Co., Bridgeport, Conn. Filed April 5, 1901. Serial No. 54,495.

718,950. Acetylene-Gas Generator. Theodor H. J. Leckband, Des Moines, Iowa, assignor, by direct and mesne assignments, to Alfred C. Einstein, St. Louis, Mo. Filed Feb. 2, 1901. Serial No. 45,693.

718,959. Gas-Regulating Valve. Thomas Wilson, Philadelphia, Pa., assignor to Pennsylvania Globe Gas Light Company, Philadelphia, Pa., a Corporation of Pennsylvania. Filed Nov. 4, 1902. Serial No. 130,077.

January 27.

719,045. Rotary Gas-Engine. Otto G. Rieske, Dayton, Ky., assignor of two-thirds to James J. Grogan and James E. O'Connell, Cincinnati, Ohio. Filed Dec. 16, 1901. Serial No. 86,139.

719,072. Spark-Igniting Mechanism for Explosive-Engines. Charles G. Annesley, Buffalo, N. Y., assignor to the Buffalo Gasolene Motor Company, Buffalo, N. Y., a Corporation of New York. Filed Sept. 13, 1901. Serial No. 75,274.

719,091. Acetylene-Gas Generator. Augustine Davis, Chicago, Ill., assignor to Davis Acetylene Company, Chicago, Ill., a Corporation of South Dakota. Filed Jan. 20, 1902. Serial No. 90,464.

719,174. Self-Igniting Mantle. Richard E. Berthold, New York, N. Y. Filed Sept. 5, 1902. Serial No. 122,155.

719,199. Internal-Combustion Engine. Charles E. Dawson, Hythe, England. Filed Dec. 10, 1900. Serial No. 39,427.

719,241. Lock for Gas-Cocks. Fred S. Martin, South Sioux City, Neb., assignor of one-half to Ned H. Emery, South Sioux City, Neb. Filed Sept. 3, 1902. Serial No. 121,989.

719,249. Explosive-Engine. Bert Niles, Croswell, Mich. Filed April 20, 1901. Serial No. 56,782.

719,303. Acetylene-Gas Generator. Joseph Choulet, Algiers, Algeria. Filed June 19, 1902. Serial No. 112,371.

719,326. Cooling Means for Explosive-Engines. Herman Cross, Lafayette, Ind. Filed Nov. 14, 1902. Serial No. 131,411.

719,360. Gas Process. Otto Oppelt, New Albany, Ind., assignor of one-half to Peyton N. Clarke, Louisville, Ky., and John H. Stotsenburg, New Albany, Ind. Filed Nov. 22, 1901. Serial No. 83,225.

719,373. Acetylene-Gas Generator. William A. Robertson, Alameda, Cal. Filed Oct. 18, 1900. Serial No. 33,507.

719,391. Acetylene-Gas Generator. Earl B. Stoner, Astoria, Ore. Filed April 17, 1902. Serial No. 103,418.

719,407. Combined Regulator and Safety Mechanism for Explosive-Engines. Leonidas G. Woolley, Kenton, Ohio, assignor to the Magneto Electric Company, New York, N. Y. Filed Feb. 28, 1902. Serial No. 96,192.

February 3.

719,570. Acetylene-Gas Generator. Augustine Davis, Chicago, Ill. Filed Dec. 8, 1897. Serial No. 661,121.

719,633. Acetylene-Gas Generator. Rodrick J. Atkin, and Mark R. Eagleson, Lillooet, Canada. Filed Jan. 16, 1902. Serial No. 89,972.

719,653. Rotary Gas-Engine. William M. Everett, Tenafly, N. J., assignor of one-fourth to Mandeville C. Jacobus, Englewood, N. J. Filed July 28, 1899. Serial No. 725,353.

719,665. Apparatus for Generating Acetylene Gas. John J. Hendler, Kansas City, Mo. Filed March 11, 1901. Serial No. 50,565.

719,855. Stroke-Varying Mechanism for Explosive-Engines. Albert F. Parks, Brooklyn, N. Y. Filed Jan. 23, 1902. Serial No. 90,913.

February 10.

720,065. Apparatus for Cooling Coke, Etc. Irwin W. Pike, Keyport, N. J. Filed May 1, 1902. Serial No. 105,439.

720,126. Speed-Regulator for Explosive-Engines. Lee A. Frayer, Columbus, Ohio, assignor to Columbus Machine Co., Columbus, Ohio. Filed Nov. 10, 1902. Serial No. 130,783.

720,134. Convertible Gas-Mixer. William E. Guese, Toledo, Ohio, assignor of one-half to George A. Fox, Toledo, Ohio. Filed Nov. 19, 1902. Serial No. 131,949.

720,180. Acetylene-Gas Generator. Joseph K. Rush, Canandaigua, N. Y. Filed July 5, 1901. Serial No. 67,104.

720,275. Gas-Burner. Ulysses S. McCormick, Buffalo, N. Y., assignor to White Light Burner Company, Buffalo, N. Y., a Firm. Filed Nov. 7, 1902. Serial No. 130,429.

720,303. Gas-Burner for Stoves. Charles F. Wilson, Catlettsburg, Ky. Filed May 28, 1902. Serial No. 109,354.

720,433. Fixture for Incandescent Gas-Lights. Joseph Hutchinson, New York, N. Y., assignor of one-half to Alanson T. Enos, New York, N. Y. Filed April 23, 1901. Serial No. 57,040.

720,539. Burner-Cap for Incandescent Gas-Burners. James N. Webb, Waterbury, Conn., assignor to Benedict & Burnham Manufacturing Company, Waterbury, Conn., a Corporation of Connecticut. Filed April 11, 1902. Serial No. 102,419.

February 17.

720,618. Incandescent Burner. Alcorn Rector, New York, N. Y. Filed April 12, 1902. Serial No. 102,629.

720,752. Internal-Combustion Engine. Constantine L. Straub, Perth Amboy, N. J. Filed March 14, 1902. Serial No. 98,252.

720,759. Explosive-Engine. Henry W. Tuttle, Philadelphia, Pa., assignor to John M. Scott, Philadelphia, Pa. Filed May 2, 1902. Serial No. 105,599.

720,780. Gas-Retort. Julius Bueb, Dessau, Germany. Filed June 2, 1902. Serial No. 109,992.

720,805. Gas-Light. Hugo Herz, Chicago, Ill. Filed Oct. 27, 1902. Serial No. 128,928.

720,976. Acetylene-Gas Generator. William E. Scofield, Long Island City, N. Y., assignor to the Sunlight Gas Machine Company, New York, N. Y., a Corporation of New Jersey. Filed Dec. 28, 1901. Serial No. 88,439.

720,995. Cooling Device for Explosive-Engines. Chas. A. Bailey, Cromwell, Conn. Filed Oct. 13, 1902. Serial No. 127,069.

721,026. Gas-Meter. John W. Culmer, Cleveland, Ohio, assignor to Edgar M. Moore, Allegheny, Pa. Filed Dec. 26, 1901. Serial No. 87,168.

721,065. Gas-Engine Igniter. Louis P. Möoers, Cleveland, Ohio, assignor, by mesne assignments, to Peerless Motor Car Company, Cleveland, Ohio, a Corporation of West Virginia. Filed Oct. 24, 1901. Serial No. 79,750.

February 24.

721,285. Igniter for Gas-Engines. Joseph Cereghino, San Francisco, Cal. Filed July 8, 1902. Serial No 114,788.

721,308. Safety Gas-Cock. Laurits Jensen and Jens Christensen, San Francisco, Cal. Filed Nov. 1, 1902. Serial No. 129,778.

721,495. Condensing Gas-Stove. Thomas Bamforth, Carron, Scotland, and Frederick R. E. Branston, East Molesey, England. Filed Oct. 7, 1902. Serial No. 126,315.

721,513. Gas-Producer. Lucien Genty, Marseilles, France, assignor to himself, and La Société Générale des Industries Economiques, Paris, France. Filed Nov. 4, 1901. Serial No. 81,040.

721,650. Incandescent Gas-Lamp. Winfield S. Proskey, Ocala, Fla. Filed April 19, 1902. Serial No. 103,754.

March 3.

721,872. Explosive-Engine. Anton Evensen, Chicago, Ill., assignor of one-half to Charles R. Hannan, Council Bluffs, Iowa. Filed Nov. 2, 1900. Serial No. 35,203.

721,873. Sparking Igniter for Explosive-Engines. Anton Evensen, Chicago, Ill., assignor of one-half to Charles R. Hannan, Council Bluffs, Iowa. Original application filed Nov. 2, 1900. Serial No. 35,203. Divided and this application filed March 11, 1901. Serial No. 50,617.

721,952. Gas-Retort Discharging Apparatus. Walter R. Herring, Edinburgh, Scotland. Filed Oct. 6, 1902. Serial No. 126,110.

721,972. Gas-Regulating System. George R. Siefken, Chicago, Ill. Filed May 17, 1902. Serial No. 107,811.

721,997. Gas-Burner. William B. Carrick, Chicago, Ill. Filed April 28, 1902. Serial No. 104,962.

722,005. Sparking Igniter for Explosive-Engines. Charles E. Duryea, Peoria, Ill. Filed April 3, 1900. Serial No. 11,313.

722,027. Safety Gas-Burner. John B. Loughead, Elizabeth, N. J. Filed April 2, 1902. Serial No. 101,061.

722,147. Burner for Incandescent Gas-Lighting. Thos. J. F. Ryland, London, England. Filed Dec. 12, 1902. Serial No. 134,993.

722,176. System of Producing Electrical Sparks for Igniting the Charges of Explosive-Engines. George W. Euker, Richmond, Va., assignor to Edwin O. Meyer, Richmond, Va. Filed July 9, 1902. Serial No. 114,850.

722,181. Acetylene-Gas Generator. David N. Long, Buffalo, N. Y., assignor, by mesne assignments, to J. B. Colt Company, a Corporation of New Jersey. Original application filed Jan. 16, 1896. Serial No. 575,711. Divided and this application filed Aug. 25, 1900. Serial No. 28,068.

March 10.

722,223. Gas or Gasolene Engine. Bernt Garllus, Madison, Wis. Filed Dec. 7, 1901. Serial No. 85,105.

722,226. Gas Burner. Carl F. Glocker, Albany, N. Y. Filed May 16, 1901. Serial No. 60,569.

722,302. Automatic Gas Regulating Valve. Clarence M. Holley and Milton H. Rix, Ann Arbor, Mich., assignors to Holley Heat Regulator Company, Detroit, Mich., a Corporation of Michigan. Filed Feb. 3, 1902. Serial No. 92,320.

722,306. Gas Lamp. Alfred H. Humphrey, Kalamazoo, Mich. Filed Nov. 3, 1902. Serial No. 129,914.

722,389. Gas-Meter. Henry H. Sprague, Bridgeport, Conn. Filed May 24, 1901. Serial No. 61,729.

722,390. Gas-Meter. Henry H. Sprague, Saugatuck, Conn. Filed April 5, 1902. Serial No. 101,513.

722,414. Gas-Range. George A. Simpson, Pittsburg, Pa., assignor of one-fourth to Wilbur A. Kessler, Pittsburg, Pa. Filed July 18, 1901. Serial No. 68,814.

722,554. Coin-Freed Mechanism for Gas or other Fluid Meters. Bertram R. Beale and Alfred E. Bagnall, London, England. Filed Nov. 7, 1901. Serial No. 81,402.

722,599. Coke-Drawing Machine. Burton J. Matteson, Trinidad, Colo. Filed Aug. 5, 1902. Serial No. 118,535.

722,629. Internal-Combustion Engine. Carl C. Riotte and Carlton R. Radcliffe, New York, N. Y., assignors, by mesne assignments, to United States Long Distance Automobile Company, Jersey City, N. J., a Corporation of New Jersey. Filed Sept. 11, 1902. Serial No. 122,913.

March 17.

722,671. Gas-Engine. Leopold F. Burger, Anderson, Ind., assignor to Woolley Foundry and Machine Works, Anderson, Ind. Filed Oct. 21, 1901. Serial No. 79,374.

722,672. Valve for Gas-Engines. Leopold F. Burger, Anderson, Ind., assignor to Woolley Foundry and Machine Works, Anderson, Ind. Filed Nov. 11, 1901. Serial No. 82,070.

722,774. Explosive-Engine. Frederick W. Toedt, Hamburg, Iowa. Filed Feb. 28, 1902. Serial No. 96,083.

722,787. Gas-Engine. George Westinghouse and Edwin Ruud, Pittsburg, Pa., assignors to the Westinghouse Machine Company, a Corporation of Pennsylvania. Filed March 31, 1898. Serial No. 675,891.

722,834. Gas-Holder. John H. Green, St. Louis, Mo., assignor, by mesne assignments, to National Light, Heat and Power Company, St. Louis, Mo., a Corporation of Missouri. Filed March 5, 1900. Serial No. 7,259.

722,846. Cylinder for Explosive-Engines. Lawrence M. Johnston, Dayton, Ohio. Filed June 5, 1899. Serial No. 719,510.

722,876. Gas-Regulator. Carl L. Nelson, Seattle, Wash. Filed May 5, 1902. Serial No. 106,080.

722,915. Incandescent-Mantle Lamp. Edward A. Schoettel, New York, N. Y. Filed Dec. 5, 1902. Serial No. 133,962.

723,003. Gas-Cooler. Edwin A. Moore, Philadelphia, Pa. Filed June 5, 1902. Serial No. 110,377.

723,071. Double-Acting Four-Cycle Explosion-Motor. Albert Thiéry, Marcinelle, Belgium. Filed May 2, 1902. Serial No. 105,653.

723,092. Acetylene-Gas Generator. William Webb, Ypsilanti, Mich., assignor of one-half to Benjamin F. Savery, Ypsilanti, Mich. Filed June 20, 1902. Serial No. 112,434.

723,098. Cooling-Tank for Internal-Combustion Engines. Clarence O. White, Minneapolis, Minn., assignor to Globe Iron Works, Minneapolis, Minn., a Corporation. Filed Jan. 29, 1901. Serial No. 45,245.

723,138. Acetylene-Gas Generator. John Condon, Philadelphia, Pa., assignor to Sunlight by Night Acetylene Gas Company, Charleston, W. Va., and Philadelphia, Pa., a Corporation of West Virginia. Filed Dec. 5, 1901. Serial No. 84,765.

723,160. Mechanism for Automatically Operating Exhaust-Valves on Explosive-Engines. James E. Jones, Richmond, Ind. Filed Jan. 21, 1902. Serial No. 90,689.

723,224. Gas-Producer. Frederick W. Matthiessen, Lasalle, Ill. Filed June 12, 1902. Serial No. 111,258.

March 24.

723,331. Gas-Lighter. Aaron P. Storrs, Oswego, N. Y. Filed Jan. 28, 1902. Serial No. 91,543.

723,402. Gas-Valve. Lory M. Moore and Walter J. Irvin, Akron, Ohio. Filed Dec. 6, 1902. Serial No. 134,141.

723,411. Acetylene-Gas Generator. August Schweitzer, Glendora, Cal. Filed June 18, 1902. Serial No. 112,241.

723,479. Coke-Pusher. Edwin A. Moore, Philadelphia, Pa. Filed June 5, 1902. Serial No. 110,380.

723,493. Double Coke-Pusher. Frederic W. C. Schniewind, New York, N. Y., assignor to the United Coke and Gas Company, New York, N. Y., a Corporation of West Virginia. Filed June 5, 1902. Serial No. 110,358.

723,514. Gas-Furnace. Edwin S. Clower, Philadelphia, Pa. Filed Sept. 29, 1902. Serial No. 125,230.

723,540. Igniter-Operating Mechanism for Explosive-Engines. Theodore C. Menges, Waterloo, Iowa, assignor to Cascaden Manufacturing Company, Waterloo, Iowa, a Corporation. Filed Aug. 29, 1902. Serial No. 121,475.

723,667. Incandescent Gas-Burner. Alfred Grossmann, Leipzig, Germany. Filed Dec. 23, 1902. Serial No. 136,337.

723,668. Recuperative Gas-Furnace. Lazenby C. Hamlink, St. Louis, Mo., assignor to Laclede Fire Brick Manufacturing Company, St. Louis, Mo., a Corporation. Filed Oct. 30, 1901. Serial No. 80,497.

723,751. Apparatus for Indicating the Thermal Quality of Gases. Wilbur F. Steele, New York, N. Y., assignor to Acme Gas Company, New York, N. Y. Filed April 14, 1902. Serial No. 102,808.

723,778. Acetylene-Gas Generator. George W. MacKenzie, Beaver, Pa. Filed Dec. 26, 1900. Renewed Jan. 10, 1903. Serial No. 138,519.

723,779. Acetylene-Gas Generator. George W. MacKenzie, Beaver, Pa. Filed Oct. 14, 1901. Renewed Jan. 10, 1903. Serial No. 138,520.

March 31.

723,814. Gas-Producing Plant. Frederic E. Bowman, Manchester, England. Filed March 11, 1902. Serial No. 97,756.

723,844. Gas-Engine. Allen H. Dingham, Dehaven, Pa. Filed Oct. 24, 1901. Serial No. 79,843.

723,897. Gas-Producer. Charles H. Morgan, Worcester, Mass., assignor to Morgan Construction Company, Worcester, Mass., a Corporation of Massachusetts. Filed July 21, 1902. Serial No. 116,436.

723,956. Explosive-Engine. Carl W. Weiss, New York, N. Y., assignor of one-half to August Mietz, New York, N. Y. Filed Nov. 10, 1898. Serial No. 696,017.

724,030. Gas and Tar Separator. Edwin A. Moore, Philadelphia, Pa. Filed June 5, 1902. Serial No. 110,376.

724,031. Gas-Cooler. Edwin A. Moore, Philadelphia, Pa. Filed June 5, 1902. Serial No. 110,378.

724,035. Apparatus for Regulating the Gas-Pressure in Burners. Moses Offenberg, Berlin, Germany. Filed Dec. 11, 1901. Serial No. 85,538.

724,239. Compound Gas-Engine. James Babled, Dallas, Texas. Filed March 7, 1901. Serial No. 50,155.

724,280. Acetylene-Gas Generator. Nelson Goodyear, Flushing, N.Y., assignor to J. B. Colt Company, a Corporation of New Jersey. Filed June 24, 1901. Serial No. 65,813.

724,281. Acetylene-Gas Generator. Nelson Goodyear, Flushing, N.Y., assignor to J. B. Colt Company, a Corporation of New Jersey. Filed Dec. 17, 1901. Serial No. 86,198.

724,328. Mixing-Valve for Explosion-Engines. Maurice Pivert, New Orleans, La. Filed June 5, 1902. Serial No. 110,313.

724,357. Gas-Generating System. Charles Whitfield, Kettering, England. Filed Dec. 5, 1901. Serial No. 84,754.

724,374. Acetylene-Gas Generator. Frank M. Ashley, New York, N. Y. Filed May 25, 1899. Serial No. 718,233.

April 7.

724,606. Air and Gas Engine. John B. O'Donnell, Kansas City, Mo., Ella M. O'Donnell, administratrix of said John B. O'Donnell, deceased, assignor of one-fourth to James R. Pollard, Kansas City, Mo. Filed July 24, 1902. Serial No. 116,825.

724,612. Gas Burner and Regulator for Same. Allison A. Pratt, New York, N. Y., assignor to Francis D. Warren, New Castle, Ind. Filed March 15, 1902. Serial No. 98,325.

724,642. Acetylene-Gas Generator. George L. Wilson, Oakpark, Ill. Filed May 31, 1901. Serial No. 62,556.

724,649. Sparking Mechanism for Engines. Abraham M. Zimmerman, New Holland, Pa. Filed July 26, 1902. Serial No. 117,179.

724,945. Ignition-Plug for Explosive-Engines. William Roche, Jersey City, N. J. Filed Aug. 16, 1902. Serial No. 119,843.

April 14.

725,087. Oscillating-Piston Explosive-Engine. James A. Jenney, Fairhaven, Mass. Filed Sept. 18, 1902. Serial No. 123,835.

725,089. Adjustable Gas-Check. John F. W. Jost, Philadelphia, Pa. Filed March 20, 1901. Renewed Sept. 17, 1902. Serial No. 123,722.

725,104. Ignition-Chamber for Gas-Engines. Abbot A. Low, Brooklyn, N. Y. Filed June 11, 1901. Serial No. 64,111.

725,110. Gas-Burner. Edwin C. Merrill, Pittsburg, Pa. Filed March 25, 1901. Serial No. 52,802.

725,198. Acetylene-Gas Apparatus. Davis Barnard, Bakersfield, Cal., assignor to Dave Barnard & Company, Bakersfield, Cal. Filed July 16, 1902. Serial No. 115,839.

725,199. Incandescent Gas-Light. George S. Barrows, Philadelphia, Pa., assignor to Welsbach Light Company, Gloucester City, N. J., a Corporation of New Jersey. Filed May 26, 1896. Serial No. 593,146.

725,295. Gas-Engine. Henrik C. Sträng, Chicago, Ill. Filed July 10, 1899. Serial No. 723,332.

725,366. Acetylene-Gas Generator. Nils A. Renstrom, Omaha, Neb. Filed May 6, 1902. Serial No. 106,215.

725,369. Automatic Fuel-Feeding Device for Gas-Producers. Jas. G. Sanderson, Scranton, Pa. Filed March 22, 1902. Serial No. 99,478.

725,372. Caloric-Engine for Supplying Gas Lamps with Fuel. Charles Scott-Snell, Westminster, England. Filed July 25, 1902. Serial No. 117,008.

725,379. Muffler for Engines. Ralph P. Thompson, Springfield, Ohio. Filed Feb. 1, 1902. Serial No. 92,097.

725,466. Acetylene-Gas Generator. Charles W. Metcalf, San Diego, Cal. Filed Dec. 19, 1902. Serial No. 135,865.

725,470. Gas-Works Valve. Edwin A. Moore, Philadelphia, Pa. Filed June 5, 1902. Serial No. 110,375.

725,556. Electric Igniter for Explosive-Engines. George A. Goodson, Minneapolis, Minn. Filed March 17, 1902. Serial No. 98,465.

725,644. Electric Igniter for Explosive-Engines. George A. Goodson, Providence, R. I. Filed Dec. 26, 1902. Serial No. 136,527.

April 21.

725,660. Safety Gas-Cock. Gustave E. Biot, Brooklyn, N. Y. Filed July 11, 1902. Serial No. 115,145.

725,668. Governing Mechanism for Gas-Engines. Leopold F. Burger, Anderson, Ind., assignor to Woolley Foundry and Machine Works, Anderson, Ind. Filed Nov. 11, 1901. Serial No. 81,939.

725,669. Speed-Governing Mechanism. Leopold F. Burger, Anderson, Ind., assignor to Woolley Foundry and Machine Works, Anderson, Ind. Filed March 27, 1902. Serial No. 100,242.

725,789. Explosion Engine. Louis F. Splitt, Layton Park, Wis. Filed July 16, 1900. Serial No. 23,736.

725,947. Incandescent Gas-Burner. John H. Findlay, Ogdensburg, N. Y. Filed June 20, 1902. Serial No. 112,463.

725,990. Internal-Combustion Engine. Andrew L. Riker, Shorthills, N. J., assignor to the "Locomobile" Company of America, New York, N. Y., a Corporation of West Virginia. Filed July 16, 1902. Serial No. 115,843.

726,139. Acetylene-Gas-Generating Apparatus. Chas. Busch, Paris, France. Filed June 10, 1901. Serial No. 63,965.

726,226. Explosive-Engine. August Krastin, Cleveland, Ohio, assignor to the Krastin Automobile Company, Cleveland, Ohio. Filed Aug. 5, 1901. Serial No. 70,942.

April 28.

726,238. Gas and Air Mixer. David J. Archer, Toronto, Canada. Filed July 11, 1902. Serial No. 115,212.

726,353. Rotary Explosive-Engine. Paul C. Sainsevain, San José, Cal., assignor of one-half to Alphonse G. Col, San José, Cal. Filed June 12, 1902. Serial No. 111,265.

726,490. Safety Gas-Burner. Henry W. Yerrington, Oceanic, N. J. Filed Nov. 17, 1902. Serial No. 131,775.

726,522. Automatic Shut-Off for Gas or Oil. Charles Fox and John A. Waters, Stamford, Conn. Filed Jan. 26, 1903. Serial No. 140,545.

726,710. Gas or Explosive Engine. Leon A. C. Letombe, Lille, France. Original application filed June 1, 1901. Serial No. 62,696. Divided and this application filed Oct. 15, 1901. Serial No. 78,671.

726,731. Gas-Engine. Walter J. McVicker, Rogers, Neb. Filed Nov. 25, 1901. Serial No. 83,576.

726,757. Gas-Producer. Josef Reuleaux, Wilkinsburg, Pa., assignor to Alexander Laughlin, Sewickley, Pa. Filed Jan. 12, 1903. Serial No. 138,767.

May 5.

726,910. Gas-Burner. Albert E. Hartel, Philadelphia, Pa., assignor, by mesne assignments, to The Hartel Light Company, a Corporation of Delaware. Filed May 9, 1902. Serial No. 106,589.

726,923. Gas Lighting and Heating Apparatus. Chas. W. Hinman, Boston, Mass. Filed March 1, 1902. Serial No. 96,230.

726,924. Gas Lighting and Heating Apparatus. Chas. W. Hinman, Boston, Mass. Filed April 16, 1902. Serial No. 103,125.

726,925. Gas Lighting and Heating Apparatus. Chas. W. Hinman, Boston, Mass. Filed April 17, 1902. Renewed Feb. 16, 1903. Serial No. 143,638.

726,949. Gas-Generator. Adolf Langen, Cologne, Germany. Filed Feb. 16, 1903. Serial No. 143,705.

726,962 Gas-Regulator. Gustav Metzger, Newark, N. J. Filed May 14, 1902. Serial No. 107,272.

727,158. Incandescent Igniter for Gas-Engines. James S. Lang, Boston, Mass. Filed April 16, 1902. Serial No. 103,122.

727,205. Valve for Gas or Other Pipes. Edward S. Root and Chas. S. Demarest, New York, N. Y. Filed Dec. 6, 1902. Serial No. 134,097.

727,257. Gas-Burner. Adolf Bachner, Frankfort-on-the-Main, Germany. Filed July 21, 1902. Serial No. 116,412.

727,266. Process of Purifying Gas. James A. Bellon-Lencauchez (called J. A. Lencauchez), Paris, France. Filed Aug. 6, 1901. Serial No. 71,058.

727,399. Sparking Igniter for Explosive-Engines. Emil Maerky, Philadelphia, Pa. Filed Nov. 23, 1901. Serial No. 83,418.

727,455. Explosion-Engine. Martin H. Rumpf, Paris, France. Filed Oct. 25, 1901. Serial No. 79,989.

May 12.

727,564. Regulator for Gas-Engines. Vincent G. Apple, Dayton, Ohio. Filed Oct. 16, 1901. Serial No. 78,787.

727,588. Gas-Burner. William C. Clarke, New York, N. Y., assignor to De Lery Light Company, a Corporation of New Jersey. Filed July 17, 1902. Serial No. 115,887.

727,873. Gas-Burner. Charles M. Armstrong, Toronto, Canada. Filed March 21, 1902. Serial No. 99,280.

727,917. Rotary Valve for Gas-Engines. Silas H. Dyer, Pawtucket, R. I., assignor of one-half to Edmund W. Orswell, Pawtucket, R. I. Filed Oct. 5, 1900. Serial No. 32,065.

727,944. Controlling Mechanism for Internal-Combustion Engines. Carl O. Hedstrom, Portland, Conn., assignor to George M. Hendee, Springfield, Mass. Filed Oct. 28, 1901. Serial No. 80,194.

727,961. Gas-Fixture. Sheldon Joseph, Wheeling, W. Va., assignor of one-fourth to William F. Shaffer, Wheeling, W. Va., and John Hunker, Connellsville, Pa. Filed April 3, 1902. Serial No. 101,240.

728,123. Gas-Engine Starter. Reuben A. Mitchell and Lester L. Lewis, Oil City, Pa., assignors of one-sixteenth to John F. Davis, Oil City, Pa. Filed Dec. 28, 1901. Serial No. 87,612.

728,153. Gas-Regulator. George S. Bennett, San Francisco, Cal., assignor to Oscar C. Hamlet and Daniel P. Foley, San Francisco, Cal. Filed Sept. 13, 1902. Serial No. 123,305.

May 19.

728,237. Acetylene-Gas Generator. Alva Hunt and James D. Baughman, Pulaski, Iowa. Filed June 19, 1902. Serial No. 112,353.

728,242. Lighting Device for Incandescent Gas-Burners. James Keith and George Keith, London, England. Filed Aug. 19, 1902. Serial No. 120,257.

728,267. Automatic Cut-Off for Gas Stoves. Frederick C. Miller, Newport, Ky. Filed July 15, 1901. Serial No. 68,334.

728,297. Regulating Device for Internal-Combustion Engines. Fritz Reichenbach, Berlin, Germany. Filed Nov. 26, 1902. Serial No. 132,901.

728,361. Gas-Pressure-Reducing Apparatus. Arthur R. Bullock, Cleveland, Ohio, assignor to Benjamin Parmely, Jr., Cleveland, Ohio. Filed July 13, 1899. Serial No. 723,676.

728,390. Hot-Coke Conveyor. Maurice Graham, Leeds, England. Filed Feb. 2, 1903. Serial No. 141,575.

728,543. Internal-Combustion Engine. Robert D. Chandler, Fairhaven, N. J. Filed April 5, 1902. Serial No. 101,542.

728,724. Internal-Combustion Engine. James H. Jones, Springfield, Mass. Filed Oct. 16, 1902. Serial No. 127,496.

728,747. Electric Igniter for Hydrocarbon-Engines. Harry M. McCall, Pittsburg, Pa., assignor to Pittsburg Gas Engine Company, Pittsburg, Pa. Filed Feb. 27, 1902. Serial No. 95,910.

728,783. Gas-Regulating Burner. Clarence W. Taylor, Sioux City, Iowa. Filed Sept. 12, 1902. Serial No. 123,152.

May 26.

728,882. Electrical Ignition Apparatus for Gas-Engines. Willard E. Dow, Braintree, Mass. Filed Aug. 2, 1902. Serial No. 118,033.

728,950. Sparking Igniter for Explosive-Engines. Alonzo C. Mather, Chicago, Ill. Filed Sept. 26, 1900. Serial No. 31,190.

728,991. Process of Enriching Gas. Frederic W. C. Schniewind, Everett, Mass., assignor to the United Coke and Gas Company, Charleston, W. Va., and Philadelphia, Pa., a Corporation of West Virginia. Filed Jan. 23, 1900. Serial No. 2,436.

729,069. Rotary Gas-Motor. Charles Hoff, Cincinnati, Ohio, assignor of one-half to John Lewis Rombach and Theodore Groene, Cincinnati, Ohio. Filed April 29, 1901. Serial No. 57,909.

729,194. Gas-Engine. John MacHaffie, Schenectady, N. Y., assignor to General Electric Co., a Corporation of New York. Filed Aug. 12, 1901. Serial No. 71,676.

729,243. Gas-Check for Bunsen Burners. Alfred A. Ury, New York, N. Y. Filed Aug. 6, 1902. Serial No. 118,587.

729,259. Apparatus for Charging Retorts. Léon Bertrand, Paris, France. Filed Feb. 5, 1902. Serial No. 92,733.

729,271. Gas-Governor. Delos H. Bumpus, Centerview, Ohio, assignor of one-half to John W. Hutchinson, Centerview, Ohio. Filed Sept. 10, 1902. Serial No. 122,790.

729,298. Bunsen Tube for Incandescent Light, Heating or Cooking Apparatus. Charles P. Ehmann, Manchester, England. Filed Oct. 7, 1901. Serial No. 77,887.

729,339. Acetylene-Gas Apparatus. John J. Hendler, Kansas City, Mo. Filed May 8, 1901. Serial No. 59,275.

729,467. Explosion-Engine. John C. White, Decatur, Ill., assignor to William L. Oakes, Decatur, Ill. Filed March 26, 1902. Serial No. 100,134.

729,470. Gas-Burner. Charles T. Willson, Amenia, N. Y. Filed Aug. 9, 1902. Serial No. 119,115.

729,471. Gas-Burner and Self-Igniter. Charles T. Willson, Amenia, N. Y. Filed Feb. 9, 1903. Serial No. 142,499.

729,499. Igniter for Gas-Engines. John MacHaffie, Schenectady, N.Y. Original application filed Aug. 12, 1901. Serial No. 71,676. Divided and this application filed Oct. 3, 1902. Serial No. 125,813.

729,510. Acetylene-Gas Generator. Howard L. Pyle, Wilmington, Del. Filed June 3, 1902. Serial No. 110,116.

729,516. Gas-Burner. Richard Steilberg, Charlottenburg, Germany. Filed Feb. 25, 1903. Serial No. 145,008.

June 2.

729,623. Acetylene-Gas Generator. Howard E. Marsh, New York, N. Y., assignor of two-thirds to Minnie Whitney Denne, New York, N.Y. Filed Aug. 8, 1902. Serial No. 118,865.

729,670. Attachments for Gas-Stoves. Donald W. Ross, Chicago, Ill. Filed May 17, 1902. Serial No. 107,789.

729,700. Gas-Engine. Ralph P. Thompson and Emil Koeb, Springfield, Ohio. Filed Nov. 8, 1901. Serial No. 81,642.

729,969. Automatic Cut-Off for Gas-Pipes. Frank P. Somers, Cleveland, Ohio. Filed March 14, 1903. Serial No. 147,805.

729,983. Internal Combustion Engine. Henning F. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed May 31, 1899. Serial No. 718,904.

729,984. Compound Internal-Combustion Engine. Henning F. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed Oct. 30, 1899. Serial No. 735,301.

730,047. Volumetric Gas-Governor. Lucius J. Richards, Springfield, Mass. Filed March 12, 1902. Serial No. 97,860.

730,056. Sparking Igniter for Explosive-Engines. Charles A. Stickney, St. Paul, Minn. Filed April 11, 1900. Serial No. 12,418.

730,057. Gas-Regulating Device for Burners. Clarence W. Taylor, Sioux City, Iowa. Filed Oct. 18, 1902. Serial No. 127,832.

730,079. Burner for Gas Compounds. Gottfried Axdorfer, Innsbruck, Austria-Hungary. Filed April 23, 1900. Serial No. 13,963.

730,084. Gas or Vapor Engine. Richard A. F. Beilfuss, Lansing, Mich. Filed July 15, 1901. Serial No. 68,391.

June 9.

730,221. Acetylene-Gas Generator. Henry Baumgarten, London, England. Filed Aug. 21, 1902. Serial No. 120,557.

730,332. Gas Tap or Cock. Frederick A. Andrews, London, England. Filed Feb. 16, 1903. Serial No. 143,672.

730,345. Two-Cycle Gas-Engine. Avon M. Coburn, Daunt, Cal. Filed June 13, 1901. Serial No. 65,055.

730,364. Incandescent-Gas-Lighting Apparatus. Thomas Gordon, Philadelphia, Pa. Filed July 26, 1901. Serial No. 69,787.

730,433. Gas or Oil Motor. Stephen M. Balzer, New York, N. Y., assignor, by mesne assignments, to Balzer Motor Company, Incorporated, a Corporation of Delaware. Filed Dec. 17, 1897. Serial No. 662,327.

730,626. Internal-Combustion Engine. Frithiof G. Ericson, Stockholm, Sweden, assignor to Aktiebolaget Svenska Motor-Och Naf-Fabriken, Stockholm, Sweden. Filed Aug. 14, 1902. Serial No. 119,628.

730,683. Gas-Engine Reversing-Gear. Milton H. Neff, Watertown, N. Y. Filed Oct. 7, 1902. Serial No. 126,310.

730,695. Explosion-Engine. Maurice Pivert, New Orleans, La. Filed June 5, 1902. Serial No. 110,312.

730,735. Atmospheric Gas-Burner. Frederick J. Beaumont, Stroud Green, England, assignor to R. and A. Main, Limited, Clerkenwell, London, England. Filed Dec. 24, 1900. Serial No. 40,961.

730,807. Gas-Distributing System. Max Toltz, St. Paul, Minn., and Arthur Lipschutz, St. Louis, Mo. Filed Sept. 10, 1902. Serial No. 122,769.

June 16.

730,941. Process of Making Producer-Gas. Frederick W. Matthiessen, Lasalle, Ill. Filed Oct. 29, 1902. Serial No. 129,215.

730,977. Automatic Gas Shut-Off. Brady M. Sheets, Eureka, W. Va. Filed Dec. 12, 1902. Serial No. 134,983.

731,001. Explosive-Engine. Edward E. Williams, Dayton, Ohio, assignor to W. P. Callahan & Co., Dayton, Ohio, a Firm. Filed Nov. 7, 1901. Serial No. 81.378.

731,088. Retort Coke-Oven. Mahlon Updike, Chicago, Ill. Filed Oct. 21, 1901. Serial No. 79,355.

731,104. Rotary Steam Explosive-Engine. David P. Fuqua, Sr., Kansas City, Mo., assignor of one-half to Fred Buchler, Jr., Kansas City, Mo. Filed March 20, 1902. Serial No. 99,152.

731,134. Electrical Igniter for Explosive-Engines. Charles E. Sargent, Chicago, Ill., assignor of three-fourths to Oliver S. Lyford, New York, N. Y., and Charles W. Hillard, trustee, Chicago, Ill. Original application filed April 27, 1900. Serial No. 14,553. Divided and this application filed Nov. 3, 1900. Serial No. 35,371.

731,236. Gas-Engine. James M. Smelser, Pendleton, Ind., assignor to the Smelser Engine Company, Frankton, Ind., a Corporation of Indiana. Filed March 10, 1902. Serial No. 97,511.

731,255. Gas-Regulator. Clarence C. Wilson, Alameda, Cal. Filed Oct. 20, 1902. Serial No. 128,087.

731,265. Cylinder for Oil, Spirit or Gas Engines. Herbert Austin, Erdington, near Birmingham, England. Filed April 23, 1902. Serial No. 104,412.

731,271. Gas-Cock. Edward D. Booz, Baltimore, Md. Filed Feb. 21, 1903. Serial No. 144,477.

731,286. Rotary Explosive-Engine. Robert Cumming, Edinburgh, Scotland. Filed Feb. 6, 1903. Serial No. 142,119.

731,376. Apparatus for Supplying Air or Other Combustion-Supporting Fluid or Substance to Gas or Other Burners. Thomas J. Litle, Jr., Philadelphia, Pa., assignor to The New Process Lighting Company, Cleveland, Ohio, a Corporation of Ohio. Filed Oct. 1, 1900. Serial No. 31,694.

731,412. Method of Treating Gas. Olaf N. Guldlin, Fort Wayne, Ind. Filed March 12, 1900. Renewed May 18, 1903. Serial No. 157,663.

June 23.

731,434. Gas Manufacturing Apparatus. Grove Cothran, Summitville, Ind., assignor, by direct and mesne assignments, to the Crude Oil Gas Company, Chicago, Ill., a Corporation of South Dakota. Filed Oct. 10, 1901. Serial No. 78,213.

731,507. Explosion-Engine. Karl Schäfferkötter, Prüm, Germany. Filed June 28, 1902. Serial No. 113,637.

731,510. Guard for Gas Burners. George Schulz, New York, N. Y. Filed Dec. 2, 1902. Serial No. 133,625.

731,548. Gas Burner. Joseph H. Diehl and Israel B. Taylor, Buffalo, N. Y.; said Taylor assignor, by mesne assignments, to Ansley D. White, Buffalo, N. Y. Filed April 22, 1902. Serial No. 104,227.

731,607. Meter for Air and Gas Mixtures. Hermanus C. Oving, Rotterdam, Netherlands. Filed March 12, 1903. Serial No. 147,467.

731,652. Process of Generating Acetylene Gas. Geo. J. Atkins, Tottenham, England. Filed June 5, 1900. Serial No. 19,121.

731,673. Dip-Pipe for Gas Apparatus. Charles R. Faben, Jr., Toledo, Ohio. Filed Aug. 22, 1902. Serial No. 120,728.

731,781. Igniter for Explosive-Engines. Thomas B. Jeffery, Kenosha, Wis. Filed March 10, 1902. Serial No. 97,444.

731,782. Automatic Gas-Igniter. Julius Jürgens, Hamburg, Germany. Filed Nov. 13, 1902. Serial No. 131,227.

731,907. Burner for Acetylene Gas. Baul Jacob and Curt Jacob, Zwickau, Germany. Filed Sept. 30, 1902. Serial No. 125,385.

731,949. Method of Making Coke and Gas. John A. Potter, Philadelphia, Pa. Filed July 8, 1901. Serial No. 67,398.

731,950. Coke Oven and Gas-Producer. John A. Potter, Pittsburgh, Pa. Filed June 24, 1902. Serial No. 112,958.

731,956. Gas-Engine. Charles Rossler, Buffalo, N. Y. Filed Feb. 27, 1902. Serial No. 95,874.

731,995. Internal-Combustion Engine. Arthur T. Collier, St. Albans, England, assignor of one-third to Arnold Elworthy Williams, London, England. Filed Feb. 16, 1903. Serial No. 143,716.

731,997. Gas-Regulator. Allan M. Fisher, East Liverpool, Ohio. Filed April 11, 1903. Serial No. 152,120.

June 30.

732,068. Automatic Gas-Burner. Cyrus A. Haas, St. Louis, Mo. Filed Feb. 27, 1902. Serial No. 95,972.

732,124. Automatic Gas Cut-Off. John E. Seymour, Columbus, Ohio. Filed Nov. 7, 1902. Serial No. 130,373.

732,193. Gas-Burner. Levi F. Knoderer, Columbus, Ohio. Filed Feb. 9, 1903. Serial No. 142,478.

732,224. Burner. Monroe L. Ross, Paris, France. Filed June 13, 1902. Serial No. 111,550.

732,243. Time-Controlled Gas-Cock. Harold H. Ward, Boreham Wood, England. Filed Dec. 1, 1902. Serial No. 133,497.

732,343. Internal-Combustion Engine. Arthur F. Evans, Cambridge, England. Filed Feb. 24, 1903. Serial No. 144,768.

732,365. Igniter for Internal-Combustion Engines. Herbert G. Mears, New York, and Henry W. Aylward, Brooklyn, N. Y., assignors, by mesne assignments, to the Auto-Igniter Company, New York, N. Y., a Corporation of New Jersey. Filed Nov. 19, 1902. Serial No. 131,972.

732,385. Inferential Gas-Meter. Thomas Thorp, Whitefield, England. Filed April 30, 1902. Serial No. 105,308.

732,455. Burner. Richard M. Shaffer, Baltimore, Md. Filed Aug. 20, 1902. Serial No. 120,336.

732,545. Hot-Coke Conveyor. Maurice Graham, Leeds, England. Filed March 10, 1903. Serial No. 147,185.

732,683. Gas-Engine. William J. Wright, Pittsburg, Pa., assignor of seven-sixteenths to John F. McKibben, J. W. Lee and Fred J. Galloway, Pittsburg, Pa. Filed July 20, 1900. Serial No. 24,324.

732,685. Gas-Burner. John E. Allen, Columbiana, Ohio, administrator of James J. Johnston, deceased, assignor to Albert C. Ellis, Pittsburg, Pa. Filed Sept. 17, 1897. Serial No. 652,052.

July 7.

732,756. Gas-Purifier. Ernest F. Lloyd, Detroit, Mich. Filed Sept. 25, 1902. Serial No. 124,742.

732,830. Regulator for Suction-Valves of Explosive Engines. Adolphe Clement, Levallois-Perret, France. Filed Oct. 9, 1902. Serial No. 126,382.

732,928. Gas Lamp. Robert M. Dixon, East Orange, N. J. Filed Feb. 21, 1903. Serial No. 144,424.

732,950. Gas Producer. André Leclere, Paris, France, assignor to Société Anonyme pour la Production et l'Emploi de la Vapeur Surchauffée, Châlon-sur-Saône, France. Filed Jan. 2, 1902. Serial No. 88,240.

732,980. Electrically-Controlled Gas-Burner and Pilot-Light. Holstein W. Webb, Columbus, Ohio. Filed May 2, 1902. Serial No. 105,604.

732,981. Gas-Check for Bunsen Burners. Louis T. Weiss, New York, N. Y., assignor to Alfred A. Ury, New York, N. Y. Filed Nov. 7, 1902. Serial No. 130,377.

733,005. Gas-Stove. William B. Cassidy, Columbus, Ohio. Filed Nov. 22, 1902. Serial No. 132,405.

733,091. Gas-Burner. Clarence W. Taylor, Sioux City, Iowa. Filed Feb. 18, 1903. Serial No. 143,929.

733,160. Gas-Burner. Bernhard Columbus, New York, N. Y. Filed June 18, 1902. Serial No. 112,205.

733,192. Incandescent Gas-Lamp. Cyrus A. Haas, St. Louis, Mo. Filed June 14, 1902. Serial No. 111,657.

733,206. Centrifugal Gas-Purifier. Herbert A. Humphrey, Westminster, London, England. Filed May 5, 1902. Serial No. 106,037.

733,220. Valve-Gear for Explosive-Engines. Arthur Krebs, Paris, France, assignor to Ste. Ame des Anciens Etablissements Panhard et Levassor, Paris, France. Filed Dec. 11, 1902. Serial No. 134,876.

733,254. Time Gas-Valve. Henry McDuffie, Jr., Fayetteville, N. C. Filed Dec. 29, 1902. Serial No. 137,030.

733,256. Gas-Engine. William E. Nageborn, Detroit, Mich. Filed June 20, 1901. Serial No. 65,376.

733,274. Gas-Furnace. Edward P. Reichhelm, Bayonne, N. J., assignor to American Gas Furnace Company, Elizabeth, N. J., a Corporation of New Jersey. Filed Oct. 11, 1902. Serial No. 126,865.

733,328. Acetylene Gas-Generator. James H. Mount, Jamesburg, N. J. Filed Dec. 24, 1902. Serial No. 136,506.

733,350. Internal-Combustion Engine. Henning F. W. Wallmann, Chicago, Ill., assignor to the Wallmann Engine Company, a Corporation of Illinois. Filed Oct. 15, 1897. Serial No. 655,357.

July 14.

733,384. Speed-Regulator for Explosive Engines. Herbert A. Gilman, Laconia, N. H., assignor of one-half to Courtland D. Lougee, Laconia, N. H. Filed Feb. 14, 1903. Serial No. 143,374.

733,417. Internal-Combustion Engine. Victor R. Nicholson, Bellevue, Cork, Ireland. Filed Jan. 3, 1903. Serial No. 137,687.

733,464. Means for Controlling the Flow of Gases. Herbert H. Dow, Midland, Mich., assignor to Dow Chemical Company, Midland, Mich., a Corporation of Michigan. Filed Feb. 13, 1902. Serial No. 93,819.

733,465. Process of Obtaining Ammonia from Ammonia-Containing Gases. Herbert H. Dow, Midland, Mich. Filed July 23, 1902. Serial No. 116,618.

733,473. Incandescent Gas-Burner. Armand Farkas, Paris, France. Filed Jan. 27, 1903. Serial No. 140,741.

733,498. Carburetter. George H. Maurer, Montreal, Canada, assignor to Alfred William Belfry, Montreal, Canada. Filed April 24, 1902. Serial No. 104,537.

733,522. Supporting Device for Incandescent Mantles. Frank A. Ward and Arthur R. Selden, Rochester, N. Y. Filed March 21, 1902. Serial No. 99,319.

733,667. Automatic Gas-Lighting Attachment. Chas. F. Mason, Dryden, N. Y. Filed March 23, 1903. Serial No. 149,183.

733,699. Gas-Stove. Daniel J. Clark, Jersey City, N. J., assignor by mesne assignments, to "Secretary," New York, N. Y., a Corporation of New York. Filed March 13, 1903. Serial No. 147,599.

733,707. Gas-Stove. Hilliary Eldridge, Jersey City, N. J., assignor to "Secretary," New York, N. Y., a Corporation of New York. Filed March 18, 1903. Serial No. 148,370.

733,740. Acetylene-Gas Generator. James S. Philpott, Windsor, Cal., assignor of one-half to George A. Nalley, Windsor, Cal. Filed March 25, 1903. Serial No. 149,509.

733,902. Air and Gas-Mixer for Explosive-Engines. Thomas Charlton, Pittsburg, Pa., assignor of one-half to Charles R. Dallas, Pittsburg, Pa. Filed Aug. 27, 1902. Serial No. 121,248.

July 21.

733,954. Gas-Regulating Means. Edwin E. Frederick, Avalon, Pa., assignor of one-fourth to Frank B. Elder, Bellevue, Pa. Filed April 9, 1903. Serial No. 151,890.

734,105. Acetylene-Gas Generator. James W. Tallmadge, Boston, Mass. Filed Dec. 3, 1902. Serial No. 133,792.

734,138. Electric Igniter for Explosive-Engines. Andrew L. Riker, New York, N. Y., assignor, by mesne assignments, to Electric Vehicle Company, Jersey City, N. J., and Hartford, Conn., a Corporation of New Jersey. Filed Jan. 8, 1900. Serial No. 759.

734,220. Combination Internal-Combustion and Compressed or Liquid Gas or Compressed or Liquid Air Engine. Frank Bryan, London, and Abel H. Bayley, Niton, Isle of Wight, England. Filed Feb. 26, 1901. Serial No. 48,973.

734,237. Gas-Engine. James D. McFarland, Jr., San Francisco, Cal., assignor of one-half to John Bruckman, San Francisco, Cal. Filed June 3, 1901. Serial No. 62,918.

734,308. Burner for Incandescent Lighting. Roger Danvin, Courbevoie, France. Filed Dec. 10, 1902. Serial No. 134,692.

734,356. Cooling Device for Explosive-Engines. Martin Offenbacher, Fürth, Germany, assignor to The Firm of Vereinigte Maschinenfabrik, Augsburg, and Maschinenbaugesellschaft, Nürnberg, A. G., Nuremberg, Germany. Filed Dec. 30, 1902. Serial No. 137,197.

734,394. Acetylene-Gas Generator. Thomas O. Arneson, Garretson, S. D. Filed March 18, 1903. Serial No. 148,362.

734,412. Acetylene-Gas Generator. William A. Feurt and Henry H. Martin, Maryville, Mo. Filed May 31, 1902. Serial No. 109,734.

734,472. Gas-Producer. John W. Seaver and Thomas R. Morgan, Cleveland, Ohio, assignors to the Wellmann-Seaver-Morgan Engineering Company, Cleveland, Ohio, a Corporation of Ohio. Filed Sept. 20, 1902. Serial No. 124,238.

July 28.

734,521. Automatic Cut-Off for Gas-Burners. Louis F. Ducker, Boston, Mass., assignor to Ducker Automatic Gas Cut-Off Company, Augusta, Me. Filed June 12, 1902. Serial No. 111,240.

734,562. Valve-Gear for Explosive-Engines. William H. Jones, Cambridge, Mass. Filed Nov. 3, 1902. Serial No. 129,843.

734,616. Acetylene-Gas Generator. Frank K. Roberts, Buffalo, N. Y., assignor to Sarah A. Roberts, Buffalo, N. Y. Filed Feb. 28, 1901. Renewed Dec. 29, 1902. Serial No. 137,067.

734,634. Acetylene-Gas Generator. Heinrich A. F. B. H. Tönnies, Groningen, Netherlands. Filed May 22, 1901. Serial No. 61,419.

734,656. Cap and Mantle-Support for Incandescent Burners. Truman R. Barnes, Shelton, Conn. Filed April 25, 1903. Serial No. 154,230.

734,668. Attachment for Welsbach or Similar Gas-Burners. George M. Clagett and Sarah C. Clagett, Brooklyn, N. Y. Filed May 14, 1903. Serial No. 157,142.

734,718. Automatic Gas Shut-Off. John L. L. Krook, Cambridge, Mass. Filed Oct. 6, 1902. Serial No. 126,036.

734,827. Rotary Explosive-Engine. Robert Cumming, Edinburgh, Scotland. Filed Aug. 27, 1903. Serial No. 121,165.

734,851. Electric Igniter for Explosive-Engines. George A. Goodson, Minneapolis, Minn. Filed Dec. 16, 1901. Serial No. 86,009.

734,852. Electric Igniter for Explosive-Engines. George A. Goodson, Providence, R. I. Filed March 13, 1903. Serial No. 147,558.

735,029. Governor Mechanism for Explosive Engines. William J. Wright, Pittsburg, Pa., assignor of three-sixteenths to J. W. Lee and Fred J. Galloway, Pittsburg, Pa. Filed Feb. 26, 1902. Serial No. 95,706.

735,035. Gas-Engine. William H. Jones, Cambridge, Mass. Original application filed Nov. 13, 1902, Serial No. 129,843. Divided and this application filed Jan. 6, 1903. Serial No. 138,027.

735,036. Igniter for Explosive Engines. William H. Jones, Cambridge, Mass. Original application filed November 13, 1902. Serial No. 129,843. Divided and this application filed Jan. 7, 1903. Serial No. 138,143.

August 4.

735,195. Gas-Igniting Device. Gustav A. W. Barkowsky, Rochester, N. Y., assignor to Gowanda Novelty Company, Gowanda, N. Y., a Corporation. Filed April 19, 1902. Renewed May 26, 1903. Serial No. 158,900.

735,196. Self-Igniting Gas-Burner. Gustav A. W. Barkowsky, Gowanda, N. Y., assignor to Gowanda Novelty Company, Gowanda, N. Y. Filed May 25, 1903. Serial No. 158,601.

735,213. Electrical Igniting Apparatus. Walter H. Cotton, Chicago, Ill., assignor to Albert Kunze, Chicago, Ill. Filed Feb. 28, 1902. Serial No. 96,108.

735,272. Process of Making Gas. William Kent, Passaic, N. J. Filed Sept. 25, 1901. Serial No. 76,442.

735,495. Gas-Producer. John W. Gayner, Salem, N. J., assignor to American Producer-Gas Furnace Company, a Corporation of New Jersey. Filed Sept. 18, 1902. Serial No. 123 812.

735,502. Acetylene-Gas Generator. Isaac L. Harris, Jacksonville, Fla. Filed Feb. 6, 1903. Serial No. 142,204.

735,541. Electric Automatic Gas Lighter and Shut-Off. Harry J. Lyons, Guyandotte, W. Va. Filed Dec. 19, 1902. Serial No. 135,852.

735,627. Explosive-Engine. William Walke, Joplin, Mo. Filed Feb. 26, 1903. Serial No. 145,151.

735,674. Sparking Igniter for Explosive Engines. William C. Matthias, Reading, Pa. Filed Jan. 29, 1902. Serial No. 91,724.

August 11.

735,751. Gas-Heater. Julius C. Goodwin, Philadelphia, Pa., assignor of one-half to Marcus H. Darrow and Frederick Chase, Philadelphia, Pa. Filed July 16, 1902. Serial No. 115,779.

735,752. Gas-Heater. Julius C. Goodwin, Philadelphia, Pa., assignor of one-half to Marcus H. Darrow and Frederick Chase, Philadelphia, Pa. Filed May 8, 1903. Serial No. 156,143.

735,800. Acetylene-Gas Generator. John McLean, Montreal, Canada. Filed Sept. 22, 1900. Serial No. 30,783.

735,912. Rebound-Preventing Device for Gas-Engines. Carl Schrotz, Cologne, Germany. Filed Feb. 7, 1901. Serial No. 46,341.

735,923. Sparking Device for Gas-Engines. James M. Wilson, Battlecreek, Mich., assignor to the Electric Sparking and Illuminating Company, Battlecreek, Mich. Filed Jan. 29, 1902. Serial No. 91,675.

735,937. Acetylene-Gas Generator. William F. Bolly, Sandusky, Ohio. Filed July 8, 1901. Renewed July 1, 1903. Serial No. 163,978.

735,964. Internal-Combustion Engine. Fred H. Gile, Greenfield, Mass., assignor of one-half to Frederick E. Wells, Greenfield, Mass. Filed July 9, 1902. Serial No. 114,937.

735,997. Igniting Attachment for Explosive-Engines. James D. McFarland, Jr., San Francisco, Cal., assignor of one-half to John Bruckman, San Francisco, Cal. Filed Dec. 12, 1901. Serial No. 85,605.

736,115. Coke-Conveyor. Ernest G. B. Körting, Berlin, Germany. Filed March 13, 1901. Serial No. 50,936.

736,132. Gas-Engine. Herbert H. Mulherin, St. Louis, Mo., assignor to International Motor Company, St. Louis, Mo., a Corporation of Missouri. Filed March 2, 1901. Serial No. 49,568.

736,151. Rotary Explosive Motor. Alexandre Primat, Paris, France. Filed Jan. 23, 1903. Serial No. 140,245.

736,224. Gas-Engine. Everett B. Cushman and Leslie S. Cushman, Lincoln, Neb., assignors to Cushman Motor Company, Incorporated, Lincoln, Neb., a Corporation of Nebraska. Filed May 6, 1902. Serial No. 106,185.

736,287. Gas-Lamp. William D. Midgley, Buffalo, N. Y. Filed June 9, 1902. Serial No. 110,747.

August 18.

736,604. Gas-Tip. William Kramer, Brooklyn, N. Y., assignor to Gas-Tip and Self-Lighter Company, New York, N. Y., a Corporation of New York. Filed Sept. 27, 1901. Serial No. 76,799.

736,624. Clamp or Device for Stopping Leaks in Pipes. David T. Pitkethly and Jerome C. Hayes, New York, N. Y. Filed June 4, 1902. Serial No. 110,148.

736,636. Water-Gas Generator. Charles H. Schill, Manchester, and Horace H. Hills, Hyde, England. Filed January 20, 1903. Serial No. 139,834.

736,681. Gas-Lamp. Tom Brabson, Brooklyn, N. Y., assignor to Fulton Brass and Manufacturing Company, Brooklyn, N. Y., a Corporation of New York. Filed Oct. 10, 1902. Serial No. 126,655.

736,715. Direct-Acting Gas-Engine. Paul Gervais, Seeburg, Germany. Filed Jan. 2, 1902. Serial No. 88,078.

736,734. Electric Igniter for Internal-Combustion Engines. Lewis Jones, Washington, D. C. Filed Feb. 21, 1903. Serial No. 144,521.

736,737. Sparking Igniter for Explosive-Engines. Arthur A. Karcher and Douglass E. Karcher, Lyons, Mich. Filed Feb. 12, 1903. Serial No. 143,730.

736,787. Rotary Explosive-Engine. John J. O. R. Ruliancih, Clayton, Mass. Filed Oct. 16, 1902. Serial No. 127,470.

736,807. Internal-Combustion Engine. Charles A. Wilkinson, Worcester, Mass. Filed Nov. 14, 1901. Serial No. 82,315.

736,836. Acetylene-Gas Generator. John M. Flugstad and Peter M. Flugstad, Corvallis, Mont. Filed Sept. 25, 1902. Serial No. 124,819.

736,860. Gas-Heating Stove. Edward Meininghaus, Barmen, Germany, assignor to Deutsche Heizungs-Industrie, Meininghaus Bachrodt & Co., Barmen, Prussia, Germany, a Firm. Filed May 4, 1903. Serial No. 155,482.

August 25.

736,944. Internal-Combustion Engine. Rudolf Diesel, Munich, and Hugo Güldner, Augsburg, Germany. Filed November 1, 1899. Serial No. 735,456.

736,967. Acetylene-Gas Generator. Henry Hawkins and Samuel H. Hawkins, Upton Park, England. Filed January 20, 1903. Serial No. 139,732.

737,041. Acetylene-Gas Generator. Charles M. Stroud, Minneapolis, Minn., assignor of one-half to Albert J. Murdock, Minneapolis, Minn. Filed Nov. 19, 1902. Serial No. 131,998.

737,048. Cooling Device for Explosive-Engines. Richard J. Voss, Davenport, Iowa. Filed April 6, 1903. Serial No. 151,380.

737,113. Automatic Cut-Off for Gas Pipes. Richard F. Kenehan, New York, N. Y., assignor of one-half to Joseph P. Dowdall, New York, N. Y. Filed Jan. 17, 1903. Serial No. 139,461.

737,172. Apparatus for Lighting or Extinguishing Gas-Lights from a Distance. Ernest A. P. Thiem, Husum, Germany. Filed April 15, 1903. Serial No. 152,765.

737,183. Acetylene-Gas Generator. Richard H. Welles, Kenosha, Wis., assignor to the Badger Brass Manufacturing Company, Kenosha, Wis., a Corporation of Wisconsin. Filed Nov. 8, 1902. Serial No. 130,537.

737,196. Acetylene-Gas Generator. Charles W. Beck, New York, N. Y., assignor, by mesne assignments, to Electrolite Gas Lamp Company, New York, N. Y. Filed Jan. 9, 1901. Serial No. 42,585.

737,202. Electrical Ignition Device. Everett W. Brooks, Chicago, Ill. Filed Sept. 23, 1901. Serial No. 76,309.

737,305. Manually-Controlled Gas-Burner and Pilot-Light. Holstein W. Webb, Columbus, Ohio. Filed May 8, 1902. Serial No. 106,455.

737,462. Self-Igniter for Gas-Burners. Franz C. N. Parizot, Bremen, Germany. Filed May 27, 1902. Serial No. 109,143.

737,523. Acetylene-Gas Generator. John Summerfield, Dallas, Tex. Filed May 19, 1900. Serial No. 17,239.

737,524. Acetylene-Gas Generator. John Summerfield, Dallas, Tex. Filed Nov. 26, 1902. Serial No. 132,853.

737,532. Sparking Igniter for Gas-Engines. Benjamin L. Toquet, Westport, Conn. Filed April 3, 1902. Serial No. 101,256.

September 1.

737,579. Process of Purifying Gas. Ernst Burschell, Landau, Germany. Filed Dec. 6, 1902. Serial No. 134,185.

737,593. Gas Regulating and Saving Apparatus. Haring H. Dikema, Leipzig, Germany. Filed July 9, 1902. Serial No. 114,876.

737,737. Cooling Means for Gas-Engines. Charles F. Hitchcock, Oakland, Cal., assignor, by mesne assignments, to Eagle Engine Company, San Francisco, Cal., a Corporation. Filed January 2, 1902. Serial No. 87,998.

737,747. Acetylene-Gas Generator. Jacob Kuljis, Portland, Ore., assignor to Electralene Manufacturing Company, Portland, Ore., a Corporation. Filed Nov. 15, 1901. Serial No. 82,452.

737,901. Treating Air for Use in Connection with the Manufacture of Gas. John A. Bower, Waukegan, Ill., assignor to Practical Gas Construction Company, North Chicago, Ill., a Corporation of Illinois. Filed Aug. 30, 1902. Serial No. 121,640½.

737,923. Igniter for Gas-Engines. Peter P. G. Hall, Jr., Philadelphia, Pa. Filed Dec. 22, 1902. Serial No. 136,174.

737,932. Centrifugal Apparatus for Purifying Gases. Herbert A. Humphrey, Westminster, England. Filed August 11, 1902. Serial No. 119,333.

738,004. Gas-Producer. John S. Daniels and Frederic L. Daniels, Stroud, England. Filed April 6, 1903. Serial No. 151,327.

738,030. Gas-Burner Cut-Off. Samuel Haigh, Vancouver, Canada. Filed June 3, 1903. Serial No. 159,943.

738,037. Automatic Cut-Off for Gas-Burners. Jacob Hentz, Jr., Philadelphia, Pa. Filed June 22, 1903. Serial No. 162,653.

738,070. Acetylene-Gas Generator. John H. Ross, Aston, near Birmingham, England. Filed Feb. 6, 1903. Serial No. 142,187.

September 8.

738,191. Acetylene-Gas Generator. John T. D. Heaton, Auburn, Me., assignor of one-half to Joseph Heaton, Auburn, Me. Filed June 12, 1902. Serial No. 111,360.

738,199. Adjustable Gas-Check. John F. W. Jost, Philadelphia, Pa. Filed Dec. 16, 1902. Serial No. 135,417.

738,290. Burner. Jesse T. Burr, Cleveland, Ohio. Filed March 21, 1903. Serial No. 148,812.

738,303. Process of Manufacturing Gas. Herbert S. Elworthy, London, England, assignor of one-half to Ernest Henry Williamson, London, England. Filed Sept. 17, 1902. Serial No. 123,747.

738,319. Acetylene-Gas Generator. William A. Gribble, Aubrey, Tex. Filed Jan. 31, 1903. Serial No. 141,361.

738,410. Acetylene-Gas Generator. George E. Chandler, Taunton, Mass. Filed May 31, 1900. Serial No. 18,502.

738,418. Safety Gas-Burner. Ernest A. d'Aquila, Newark, N. J., and Bernardo Martelli, New York, N. Y. Filed March 7, 1903. Serial No. 146,611.

738,420. Gas-Generator. William C. Dillon, Los Angeles, Cal., assignor of one-half to Edward Lloyd, Los Angeles, Cal. Filed Nov. 25, 1902. Serial No. 132,817.

738,431. Acetylene-Gas Generator. Charles Goodyear, New York, N. Y., assignor to J. B. Colt Company, a Corporation of New York. Filed June 24, 1901. Serial No. 65,856.

738,432. Acetylene-Gas Generator. Nelson Goodyear, Flushing, N. Y., assignor to J. B. Colt Company, a Corporation of New York. Filed Oct. 10, 1901. Serial No. 78,153.

738,433. Gas Burner. James L. Graham, Allegheny, Pa. Filed Aug. 25, 1902. Serial No. 120,920.

738,512. Incandescent Gas-Burner. Adolf Bachner, Frankfort-on-the-Main, Germany. Filed Dec. 27, 1902. Serial No. 136,824.

738,514. Acetylene-Gas Generator. Charles W. Beck, New York, N. Y., assignor to Electrolite Gas Lamp Company, a Corporation of New York. Filed May 18, 1903. Serial No. 157,634.

738,579. Automatic Gas-Extinguisher. Victor A. Strom, Alameda, Cal., assignor of three-fourths to Carl E. Strom, Edward R. Taber, and Frank H. Farmer, Alameda, Cal. Filed March 19, 1903. Serial No. 148,582.

738,624. Electric Igniting Device. Harry B. McNulty, Washington, D. C., assignor to the McNulty Incandescent Gas-Lighter Company, a Corporation of the District of Columbia. Filed Feb. 13, 1903. Serial No. 143,256.

738,690. Explosive Engine. Jesse D. Lyon, Pittsburg, Pa. Filed Jan. 28, 1902. Serial No. 91,591.

738,711. Lighting Attachment for Gas-Burners. Arthur G. Chubb, Ironbridge, England, assignor to Parkinson and W. & B. Cowan, Limited, Birmingham, England. Filed March 3, 1903. Serial No. 145,978.

738,746. Incandescent Burner. William Parfrey, New York, N. Y. Filed Jan. 15, 1902. Serial No. 89,851.

September 15.

738,772. Charge-Inlet Device for Explosive-Engines. Ferdinand Charron and Léonce Girardot, Paris, France. Filed March 22, 1902. Serial No. 99,493.

738,827. Acetylene-Gas Generator. Walter S. May, Clifton, Ariz. Filed Feb. 6, 1903. Serial No. 142,192.

738,855. Acetylene-Gas Generator. Lambert Snyder, Rochelle Park, N. J. Filed May 6, 1901. Serial No. 58,904.

738,860. Explosive-Engine. William W. Tuck, Richmond Hill, Abbott A. Low, Horseshoe, and August Wassmann, Hallett's Point, N. Y., assignors to said Low. Filed Jan. 8, 1902. Serial No. 88,849.

738,918. Regenerative Coke-Oven. Heinrich Koppers, Carnap, near Essen, Germany. Filed Dec. 28, 1901. Serial No. 87,641.

739,050. Explosive Engine. William J. Wright, Pittsburg, Pa., assignor of three-sixteenths to J. W. Lee and Fred J. Galloway, Pittsburg, Pa. Filed Feb. 21, 1902. Serial No. 95,097.

739,219. Explosive Engine. John H. Redfield, Spokane, Wash., assignor of one-half to Charles Grutt, Emil Grutt and Fred Grutt, Spokane, Wash. Filed April 30, 1902. Serial No. 105,385.

739,220. Explosive Engine. John H. Redfield, Spokane, Wash. Filed Nov. 21, 1902. Serial No. 132,318.

739,258. Gasometer. Nelson Goodyear, Flushing, N. Y., assignor to J. B. Colt Company, a Corporation of New York. Original application filed June 24, 1901. Serial No. 65,811. Divided and this application filed Oct. 3. 1901. Serial No. 77,349.

September 22.

739,305. GAS-PRODUCER. Alexander M. Gow, Edgewood, Pa., assignor to George Westinghouse, Pittsburg, Pa. Filed Feb. 5, 1902. Serial No. 92,620.

739,314. INCANDESCENT GAS-LAMP. Rudolph W. Huss, Chicago, Ill. Filed Feb 9, 1903. Serial No. 142,642.

739,346. REGULATING VALVE FOR GAS-BURNERS. Victor A. Rettich, New York, N. Y., assignor to Kern Incandescent Gas Light Company, New York, N. Y., a Corporation of N. J. Filed Nov. 11, 1901. Serial No. 81,841.

739,367. GAS-PRODUCING SYSTEM. George Westinghouse, Pittsburg, Pa. Filed April 10, 1900. Serial No. 12,311.

739,426. ACETYLENE-GAS GENERATOR. Clarence M. Kemp, Baltimore, Md. Filed June 23, 1902. Serial No. 112,767.

739,532. ACETYLENE-GAS GENERATOR. Francis M. Caler, Los Angeles, Cal. Filed Oct. 9, 1902. Serial No. 126,621.

739,558. GAS-BURNER. Jay H. Rath, New York, N. Y., assignor to the Rath Light Company, Wilmington, Del., a Corporation of Delaware. Filed Dec. 26, 1902. Serial No. 136,648.

739,584. GAS-BURNER. Worthy C. Buckman, Geneva, Ohio, assignor to the Geneva Automobile and Manufacturing Company, Geneva, Ohio, a Corporation of Ohio. Filed March 28, 1902. Serial No. 100,454

739,665. GAS PLANT. Heinrich Gerdes, Berlin, Germany, assignor to Julius Pintsch, Berlin, Germany. Filed March 22, 1901. Serial No. 52,455.

September 29.

739,879. INCANDESCENT GAS-BURNER. Joseph Joatton, Lyons, France, assignor to A. Michaud & Cie., Paris, France. Filed May 26, 1903. Serial No. 158,854.

739,934. INCANDESCENT GAS-LIGHT BURNER. Wilhelm H. A. Sieverts and Wilhelm C. A. Sieverts, Hamburg, Germany. Filed Dec. 9, 1902. Serial No. 134,542.

740,018. GAS-LAMP. Alfred H. Humphrey, Kalamazoo, Mich. Filed March 26, 1902. Serial No. 99,989.

740,043. ACETYLENE-GAS-BURNER. John Reid, London, England. Filed Feb. 24, 1903. Serial No. 144,879.

740,062. ELECTRIC IGNITION DEVICE FOR GAS-BURNERS. Henri de Thiersant, London, England. Filed Oct. 10, 1902. Serial No. 126,760.

740,078. COKE-OVEN. Theodor von Bauer, Berlin, Germany. Filed June 20, 1903. Serial No. 162,364.

740,088. PROPORTIONAL METER. Horace Chrisman, Pittsburg, Pa., assignor to Pittsburgh Meter Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Feb. 20, 1903. Serial No. 144,235.

740,138. Rotary Explosive-Engine. Christopher R. James, Jersey City, N. J. Filed Sept. 25, 1899. Renewed Feb. 11, 1903. Serial No. 142,963.

740,145. Safety Gas-Supply-Pipe Attachment. Frederick W. Krohn, San Francisco, Cal. Filed July 15, 1903. Serial No. 165,682.

740,150. Bunsen Gas Heating-Burner. James J. Lawler, Mount Vernon, N. Y. Filed April 21, 1902. Serial No. 103,843.

740,163. Gas-Regulator for Burners. George F. Moore, Milwaukee, Wis. Filed March 30, 1903. Serial No. 150,177.

740,253. Incandescent Lamp. Louis Denayrouze, Neuilly-sur-Seine, France. Filed April 19, 1899. Serial No. 713,538.

740,301. Gas-Meter. James J. Mulhall, Albany, N. Y. Filed July 9, 1903. Serial No. 164,877.

UNITED STATES PATENTS RELATING TO GAS.

Expired from October 1, 1902, to October 1, 1903.

October 6, 1885.

327,541. Method of Making Illuminating-Gas. Walter P. Elliott, New Brunswick, N. J. Filed Jan. 12, 1885.

327,561. Casing for Street-Cocks in Gas and Water Service. Edward Lindsley, Cleveland, Ohio. Filed Dec. 17, 1883.

327,618. Gas-Furnace. William Swindell, Allegheny, Pa. Filed Aug. 7, 1884.

327,844. Gas-Generating Apparatus. Thomas R. White, Philadelphia, Pa. Filed July 7, 1885.

327,866. Gas-Engine. Moses G. Crane, Newton, Mass. Filed Oct. 24, 1881.

327,963. Apparatus for Automatically Cutting Off Gas from Burners. Charles G. Nye, Syracuse, N. Y. Filed Nov. 26, 1884.

October 13.

327,981. Carburetter. Carlos F. Andrus, Cleveland, Ohio, assignor of one-half to Charles M. Fulkerson, same place. Filed April 16, 1885.

328,134. Gas-Scrubber. John McKay, Titusville, Pa. Filed July 29, 1885.

328,149. Apparatus for Manufacturing Gas. Levi Stevens, Washington, D. C. Filed June 6, 1884.

328,150. Apparatus for Manufacturing Illuminating-Gas. Levi Stevens, Washington, D. C. Filed June 12, 1885.

328,151. Apparatus for Manufacturing Illuminating-Gas. Levi Stevens, Washington, D. C. Filed Aug. 10, 1885.

328,170. Gas-Engine. Joseph S. Wood, Brooklyn, assignor, by direct and mesne assignments, to R. E. Dietz, New York, N. Y. Filed July 6, 1885.

328,309. Process of Purifying Coal-Gas. John G. Hawkins, Wigan, County of Lancaster, England. Filed Aug. 3, 1885.

328,368. Means for Conveying and Supplying Gas. Geo. Westinghouse, Jr., Pittsburg, Pa. Filed Feb. 3, 1885.

328,400. Apparatus for the Manufacture of Illuminating-Gas. Isaac D. Guyer, New York, N. Y. Filed March 24, 1885.

328,408. Gas-Scrubber. Charles W. Isbell, New York, N. Y. Filed Feb. 20, 1885.

October 20.

328,834. Apparatus for Generating Gas. Wm. F. Browne, Jersey City, N. J. Filed Aug. 14, 1883.

328,839. Gas-Burner. Winant B. Cole, Brooklyn, N. Y. Filed Jan. 8, 1885.

October 27.

328,914. Gas-Furnace. John Ashcroft, New York, N. Y. Filed Feb. 13, 1885.

328,942. Automatic Pressure-Regulator for Gas-Governors. William Helme, Philadelphia, Pa. Filed Sept. 11, 1885.

328,970. Gas-Engine. James F. Place, New York, N. Y., assignor to the Place Gas Engine Manufacturing Company, same place. Filed Sept. 1, 1884.

329,087. Regenerative Gas-Burner. Eilert O. Schartau, Philadelphia, Pa., assignor of one-half to Clanmar P. Hoskins, same place. Filed Dec. 23, 1884.

329,290. Apparatus for Making Water-Gas. Peter E. De Mill, Jr., Detroit, Mich. Filed May 4, 1885.

329,354. Explosive-Engine. George Asher, Balsall Heath, and John Buttress, Sparkbrooke, County of Worcester, England. Filed April 16, 1885.

November 3.

329,664. Carburetter. Lyman F. McNett, New York, N. Y., assignor to the Excelsior Gas Machine Company, same place. Filed Jan. 14, 1885.

329,776. Gas-Burner. Richard S. Robertson and Louis B. Fulton, Pittsburg, Pa. Filed Sept. 30, 1884.

329,827. Gas-Furnace. Henry H. Garrett, Pittsburg, Pa. Filed July 10, 1885.

November 10.

329,967. Process of Manufacturing Gas. John L. Stewart, Philadelphia, Pa. Filed Jan. 9, 1885.

330,122. Apparatus for Making Illuminating Gas. Chas. W. Isbell, New York, N. Y. Filed Jan. 10, 1885.

330,142. Process of Manufacturing Gas. William F. C. M. McCarty, Philadelphia, Pa., assignor to Adolph Ohl, James McC. Creighton, and Bernard C. Lauth, all of Philadelphia, Pa., and Jane Logan, Hagerstown, Md. Filed June 5, 1885.

330,165. Gas-Apparatus. Roland H. Smith, Pittsburg, Pa. Filed January 31, 1884.

330,267. Means for Gas-Distribution. Roland H. Smith, Pittsburg, Pa. Filed Sept. 17, 1885.

330,317. Gas-Engine. William A. Graham, Carlisle, Pa. Filed Aug. 18, 1885.

November 17.

330,747. Process of Producing Illuminating-Gas. Roland H. Smith, Pittsburg, Pa. Filed Sept. 4, 1885.

330,778. Apparatus for Making Gas. Walter P. Elliott, New Brunswick, N. J. Filed March 6, 1885.

November 24.

331,078. Explosive-Vapor Engine. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Oct. 23, 1884.

331,079. Explosive-Vapor Engine. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Oct. 23, 1884.

331,080. Method of Operating Gas-Engines. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Feb. 24, 1885.

331,102. Gas-Retort Lid. William T. Walker, Bishopswood Road, Highgate, County of Middlesex, England. Filed April 22, 1885.

331,210. Explosive-Vapor Engine. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Sept. 22, 1885.

331,261. Gas-Burner. John Stuertz, Philadelphia, Pa. Filed May 11, 1885.

December 1.

331,621. Apparatus for Making Illuminating-Gas. Frederic Egner, St. Louis, Mo. Filed Sept. 28, 1885.

331,686. Gas-Conveying Apparatus. Thomas A. Connolly and Anthony A. Connolly, Washington, D. C. Filed Oct. 22, 1885.

December 8.

331,903. Process of Manufacturing Illuminating-Gas. John W. Mitchell, Bayonne, N. J. Filed Aug. 14, 1885.

332,087. Apparatus for Manufacturing Non-Luminous Heating-Gas. Joshua Kidd, Fern Bank, Wandsworth Common, County of Surrey, England. Filed July 22, 1885.

December 15.

332,312. Air and Gas-Engine. Stephen Wilcox, Brooklyn, N. Y. Filed Dec. 16, 1884.

332,313. Gas-Engine. Stephen Wilcox, Brooklyn, N. Y. Filed May 22, 1885.

332,314. Gas-Engine. Stephen Wilcox, Brooklyn, N. Y. Filed Sept. 17, 1885.

332,315. Gas-Engine. Stephen Wilcox, Brooklyn, N. Y. Filed Sept. 17, 1885.

332,401. Stop-Cock Box for Water and Gas Pipes. Alonzo R. Ketchum, Buffalo, N. Y. Filed May 12, 1885.

332,447. Gas-Engine. Cephas Shelburne, Richmond, Va. Filed April 6, 1885.

332,569. Apparatus for Manufacturing Gas. John L. Stewart, Philadelphia, Pa. Filed May 31, 1884.

332,648. Safety-Key for Gas-Burners. Joseph Dutton and James H. Dutton, San Francisco, Cal. Filed July 1, 1884.

332,650. Support for Holding and Adjusting Incandescent Bodies in a Gas-Flame. Otto B. Fahnehjelm, New York, N. Y. Filed Feb. 17, 1885.

December 22.

332,770. Safety Gas-Burner. Louis Zagelmeyer, West Bay City, Mich. Filed Feb. 26, 1885.

332,957. Process of Manufacturing Illuminating-Gas. Byron Sloper, New York, N. Y. Filed Aug. 27, 1885.

December 29.

333,122. Retort-Furnace. William Foulis, Glasgow, County of Lanark, Scotland. Filed April 12, 1884.

333,215. Safety Attachment for Gas-Burners. Paul H. Grimm and Ward I. Fancher, Glen Cove, N. Y. Filed Sept. 5, 1884.

333,336. Gas-Engine. Daniel S. Regan, San Francisco, Cal. Filed Oct. 6, 1885.

January 5, 1886.

333,584. Gas-Regulator. Myron J. Amick, Portland, Ore. Filed Oct. 3, 1885.

333,587. Gas-Pressure Regulator. Samuel A. Beatty, New York, N. Y. Filed May 18, 1885.

333,653. Automatic Safety Gas-Burner. August Meyer, Baltimore, Md. Filed Jan. 24, 1883.

333,671. Gas-Burner and Carburetter. Newman A. Ransom, Chicago, Ill., assignor of one-half to John F. Greenleaf, same place. Filed July 21, 1885.

333,691. Apparatus for Manufacturing Gas. John L. Stewart, Philadelphia, Pa. Filed April 30, 1885.

333,692. Process of Manufacturing Gas. John L. Stewart, Philadelphia, Pa. Filed June 15, 1885.

333,693. Apparatus for Manufacturing Gas. John L. Stewart, Philadelphia, Pa. Filed June 25, 1885.

333,800. Means for Conveying and Supplying Gas. G. Westinghouse, Jr., Pittsburg, Pa. Filed Feb. 3, 1885.

333,823. Gas Regulator. George Bray, Blackman Lane, Leeds, County of York, England. Filed Sept. 29, 1885.

333,838. Gas-Engine. Edouard Delamare-Debouteville and Léon Paul Charles Malandin, Fontaine-le-Bourg, Seine-Inférieure, France. Filed April 14, 1884.

333,859. Process of and Apparatus for Producing Gas. Erazm. J. Jerzmanowski, New York, N. Y. Filed July 19, 1883.

333,860. Process of Producing Gas. Erazm. J. Jerzmanowski, New York, N. Y. Filed April 7, 1885.

January 12.

334,038. Governor for Gas-Engines. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Aug. 20, 1885.

334,039. Gas-Engine. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Aug. 20, 1885.

334,040. Method of Feeding and Operating Gas-Engines. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Aug. 20, 1885.

334,109. Motor-Engine Worked by Combustible Gases or Petroleum. Gottlieb Daimler, Cannstadt, Würtemberg, Germany. Filed Sept. 21, 1885.

334,127. Gas-Making Apparatus. Thomas F. Martin, Newburg, assignor to the Martin Manufacturing Company, New York, N. Y. Filed June 4, 1885.

334,286. Gas-Saving Device. George W. Reed, Saltsburg, Pa., assignor of one-half to David O. Brown, same place. Filed June 19, 1885.

334,328. Gas-Lamp. John W. Baker, Philadelphia, Pa., assignor to the Regenerative Gas Light Company, Camden, N. J. Filed May 12, 1885.

January 19.

334,447. Apparatus for Producing Gas. Philip W. Mackenzie, New York, N. Y. Filed Sept. 29, 1884.

334,572. Automatic Safety Gas-Burner. George Doutney, Brooklyn, N. Y. Filed July 24, 1885.

334,639. Stop-Off Valve for Gas. Joseph L. Chapman, Haddonfield, N. J. Filed April 23, 1885.

334,701. Process of Manufacturing Gas. Arthur O. Granger, Philadelphia, Pa., assignor to the United Gas Improvement Company, same place. Filed Sept. 29, 1885.

January 26.

334,773. Gas-Pressure Regulator. Robert F. Hatfield, New York, N. Y. Filed April 25, 1885.

334,851. Carburetting Lamp. Jules E. Dery, Brussels, Belgium. Filed Sept. 24, 1885.

334,882. Stop-Valve for Gas-Supply Systems. Edwin C. Merrill, Pittsburg, Pa. Filed Sept. 24, 1885.

334,890. Leak-Detector for Gas. Irvin M. O'Donel, Allegheny, Pa. Filed May 29, 1885.

335,038. Slide and Passage for Gas-Motor Engines. Nicolaus A. Otto, Deutz-on-the-Rhine, Germany, assignor to the Gasmotoren-Fabrik, Deutz, same place. Filed Oct. 26, 1885.

February 2.

335,156. Gas-Regulator. Nathaniel Sleeman, Birmingham, assignor, by mesne assignments, to the Sleeman Gas Saving Company, Waterbury, Conn. Filed June 8, 1885.

335,405. Apparatus for Making Gas. John C. Wands, St. Louis, Mo. Filed Oct. 24, 1885.

335,427. Apparatus for Distilling Ammoniacal Waters. Bela P. Clapp, Pawtucket, R. I. Filed Sept. 24, 1885.

335,439. Gas-Burner. John C. English, New York, N. Y. Filed Nov. 13, 1885.

335,462. Gas-Engine. Jean J. E. Lenoir, Paris, France. Filed Dec. 10, 1883.

335,467. System for Conveying Gas Under Pressure. Junius A. McCormick, Pittsburg, Pa. Filed Dec. 12, 1885.

February 9.

335,564. Gas-Engine. John Charter, Sterling, Ill. Filed Nov. 5, 1884.

335,970. Electrical Igniter for Gas-Engines. Chas. E. Skinner, Yonkers, N. Y. Filed April 6, 1885.

335,971. Gas-Engine. Halcyon Skinner and Charles E. Skinner, Yonkers, N. Y. Filed April 2, 1885.

February 16.

336,199. Means for Collecting Waste-Gas from Leaks at the Joints of Gas-Conduits. Lemuel Bannister, Philadelphia, Pa. Filed Nov. 28, 1885.

336,505. Gas-Engine. James Atkinson, Hampstead, County of Middlesex, England. Filed May 20, 1885.

February 23.

336,573. Attachment for Gas-Service Conduits. Julius Leede, Washington, D. C., and John Lawshe, Colton, Cal.; said Leede assignor to said Lawshe. Filed Jan. 6, 1886.

336,576. Incandescent Gas-Light. Charles M. Lungren, New York, N. Y. Filed Aug. 12, 1885.

March 2.

336,912. Gas-Apparatus. George W. Gogin, Boston, Mass., and Gomer Jones, Washington, D. C., said Jones assignor to said Gogin. Filed June 17, 1885.

337,012. Gas-Regulator. John E. Miller, Pittsburg, Pa., assignor of one-half to Augustus H. Heisey, same place. Filed Sept. 8, 1884.

337,130. Regenerative Gas-Burner. Harry C. Campbell, Pittsburg, Pa. Filed June 28, 1884.

337,161. Gas-Cock. Edward P. Irons, Baltimore, Md. Filed Dec. 9, 1885.

337,226. Gas-Engine. Gardner C. Anthony, Providence, R. I. Filed June 10, 1885.

337,246. Process of Purifying Coal-Gas and Obtaining Ammonia and Other Products Therefrom. Carl F. Claus, London, England. Filed May 28, 1883.

337,350. Gas-Supply Pipe. George Russell, McKeesport, Pa., assignor of one-half to Enoch H. Leizure, same place. Filed Jan. 11, 1886.

March 9.

337,408. Device for Preventing the Freezing of Gas in Pipes. John E. Kearns, Peoria, Ill. Filed May 2, 1885.

337,431. Fluid-Pressure Regulator. Oskar Pintsch, Berlin, Germany. Filed Aug. 20, 1885.

337,438. Stop-Valve for Water and Gas Mains. Wesley Royce, Toledo, assignor of one-half to Joseph F. Kilby, Sandusky, Ohio. Filed Dec. 5, 1885.

337,461. Fluid-Pressure Regulator. Lewis W. Truesdell, Owego, N. Y., assignor of one-half to Emily Headley Gere, same place. Filed Aug. 3, 1885.

337,667. Method of Conveying Gas in an Explosive Condition. John H. Dalzell, and Thomas J. McTighe, Pittsburg, Pa. Filed Dec. 17, 1885.

337,668. Method of Distributing Gas. John H. Dalzell and Thomas J. McTighe, Pittsburg, Pa. Filed Jan. 23, 1886.

March 16.

337,918. Automatic Pressure-Regulator. Joseph G. Beale, and John A. Armstrong, Leechburg, Pa. Filed Jan. 25, 1886.

338,112. Safety-Seal for Gas-Traps. William T. Smith, Providence, R. I. Filed March 27, 1885.

338,143. Gas-Burner Attachment for Stoves. John E. Dooley, St. Louis, Mo. Filed Feb. 16, 1884. Renewed June 1, 1885.

338,155. Automatic Attachment for Gas-Stoves. John N. Ives, Brooklyn, N. Y. Filed June 3, 1885.

March 23.

338,422. Gas-Regulator. Eli C. McCloy, Mount Vernon, Ohio. Filed Jan. 27, 1886.

March 30.

338,747. Electric Gas-Lighting Burner. Charles W. Holtzer, Brookline, Mass. Filed May 12, 1884.

338,748. Electric Gas-Lighting Apparatus. Charles W. Holtzer, Brookline, Mass. Filed May 12, 1884.

338,989. Apparatus for the Manufacture of Illuminating and Heating Gas. Burdett Loomis, Hartford, Conn. Filed Feb. 2, 1885.

338,990. Process of Manufacturing Gas. Burdett Loomis, Hartford, Conn. Filed April 22, 1885.

338,991. Apparatus for Manufacturing Gas. Burdett Loomis, Hartford, Conn. Filed May 12, 1885.

338,992. Process of and Apparatus for Manufacturing Gas. Burdett Loomis, Hartford, Conn. Filed Sept. 5, 1885.

April 6.

339,225. Gas-Engine. Clark Sintz, Springfield, Ohio. Filed Jan. 13, 1886.

339,409. Process of and Apparatus for Producing Gas for Lighting and Heating Purposes. Felix Hembert and Edmond Henry, Paris, France. Filed Dec. 26, 1885.

339,415. Gas-Pressure Governor. Thomas C. Hopper, Philadelphia, Pa. Filed Dec. 14, 1885.

339,471. Process of and Apparatus for Manufacturing Gas. Henry C. Rew, Chicago, Ill. Filed Oct. 6, 1885.

339,472. Process of and Apparatus for Manufacturing Gas. Henry C. Rew, Chicago, Ill. Filed Dec. 8, 1885.

April 13.

339,748. Apparatus for the Manufacture of Illuminating Gas. Henry H. Edgerton, Danbury, Conn. Filed July 26, 1884.

339,757. Gas-Pressure Regulator. Louis B. Fulton, Pittsburg, Pa. Filed Dec. 22, 1885.

339,900. Gas Holder and Mixer. Clarence M. Kemp and Charles E. Kemp, Baltimore, Md. Filed Sept. 22, 1885.

340,030. Gas-Regulating Burner. Joseph J. Butcher, and Johann H. Wüster, Newcastle-upon-Tyne, County of Northumberland, England. Filed July 28, 1885.

April 20.

340,107. Pressure-Regulator. Louis B. Fulton, Pittsburg, Pa. Filed Jan. 29, 1886.

340,112. Gas-Regulator. Henry H. Gridley, Holyoke, Mass. Filed Jan. 18, 1886.

340,231. Process of Converting Natural Gas into Illuminating-Gas. John McKay, Titusville, Pa., assignor of one-half to Walter B. Roberts and Erastus T. Roberts, same place. Filed Jan. 20, 1886.

340,232. Process of Treating Natural Gas. John McKay, Titusville, Pa. Filed Feb. 15, 1886.

340,266. Means for Preventing Leakage in Gas-Mains. George Westinghouse, Jr., Pittsburg, Pa. Filed Feb. 3, 1886.

340,267. Pipe-Joint for Gas-Mains. George Westinghouse, Jr., Pittsburg, Pa. Filed March 1, 1886.

340,268. Pipe-Joint for Gas-Mains. George Westinghouse, Jr., Pittsburg, Pa. Filed March 1, 1886.

340,282. Gas-Making Apparatus. Ellsworth S. Bryant, Alexander W. Finlayson, and George R. Couls, Detroit, Mich. Filed Oct. 15, 1885.

340,381. Automatic Cut-Off for Gas-Burners. Thomas J. L. Smiley, and Charles H. Stombs, San Francisco, Cal. Filed Aug. 13, 1885.

340,450. Pressure-Regulator for Proportional Gas-Meters. Frank Moore, Pittsburg, Pa. Filed Jan. 23, 1886.

340,453. GAS-ENGINE. Nathan E. Nash, Westerly, R. I., assignor of one-half to Robert H. Staley, Jersey City, N. J. Filed Oct. 12, 1885.

340,454. GAS-REGULATOR. Alonzo F. Olds, New York, N. Y., assignor of one-half to Charles H. Phelps, Fairfield, Conn. Filed Jan. 26, 1886.

340,495. INDICATOR FOR GAS-COCKS. Joseph B. Eaton and George Cash, Philadelphia, Pa.; said Cash assignor to Harry Keel, Brooklyn, N. Y. Filed Oct. 17, 1885.

April 27.

340,543. GAS-SCRUBBER. William R. Beal, New York, N. Y. Filed Sept. 21, 1885.

340,616. MEANS FOR TRANSPORTATION AND DISTRIBUTION OF GAS. Thomas P. Roberts, Pittsburg, Pa. Filed Dec. 24, 1885.

340,634. GAS-GENERATOR. James E. Smith, New York, assignor of three-eighths to A. W. Le Furge and Francis Buckley, both of Brooklyn, N. Y. Filed Aug. 25, 1885.

340,696. GAS-REGULATOR. Alexander Caldwell, New York, N. Y. Filed March 11, 1886.

340,951. AUTOMATIC CUT-OFF FOR GAS-BURNERS. Elias A. Jukes, St. Catharines, assignor of one-half to Arthur Jukes Johnson, Toronto, Ontario, Canada. Filed July 3, 1885.

May 4.

340,998. SCRUBBER FOR GAS-WORKS. Arthur O. Granger, Philadelphia, assignor to the United Gas Improvement Company, same place. Filed Dec. 26, 1884.

341,008. SMOKE AND GAS-CONSUMING FURNACE. Everett R. Howard, Aurora, Ill., assignor of one-half to Roswell W. Gates, same place. Filed Jan. 29, 1886.

341,014. GAS-FURNACE FOR BOILERS. William R. Jones, Braddock, Pa. Filed Dec. 18, 1885.

341,197. DEVICE FOR REGULATING AND ENRICHING ILLUMINATING-GAS. Lewis B. White, Daniel Jackson, and Martin Van Buren, New York, N. Y., assignors to Leon Abbett, Jersey City, N. J. Filed Oct. 20, 1885.

341,266. PIPE-JOINT FOR GAS-MAINS. Terrence McSweeney, Allegheny, assignor to Thomas A. Gillespie, Pittsburg, Pa. Filed March 15, 1886.

341,295. PRESSURE-REGULATOR AND CUT-OFF. George Westinghouse, Jr., Pittsburg, Pa. Filed March 13, 1886.

341,354. PROCESS OF MANUFACTURING GAS. Roland H. Smith, Pittsburg, Pa. Filed Nov. 30, 1885.

341,381. GAS-BURNER. Leonard D. Hosford and Job G. Bass, Jr., Brooklyn, N. Y., assignors to said Leonard D. Hosford. Filed Dec. 3, 1885.

May 11.

341,506. Apparatus for Manufacturing Gas. Henry C. Rew, Chicago, Ill. Filed Nov. 14, 1885.

341,538. Gas-Engine. Charles H. Andrew and Hugh Williams, Stockport, County of Chester, England. Filed July 6, 1885.

341,544. Gas-Pressure Regulator. Charles H. Baker, Meadville, Pa. Filed March 5, 1886.

341,565. Electric Gas-Lighting Apparatus. Julius Finck, San Francisco, Cal., assignor to Will & Finck, same place. Filed June 8, 1885.

341,566. Automatic Electric Gas-Lighter. Julius Finck, San Francisco, Cal., assignor to Will & Finck, same place. Filed July 30, 1885.

341,578. Apparatus for Concentrating Ammoniacal Liquor. Charles W. Isbell, New York, N. Y. Filed March 25, 1885.

341,607. Gas-Pressure Regulator. Albert Sauer and Gustav F. Sievern, Pittsburg, Pa., assignors of one-half to Carl Kahler, New York, N. Y. Filed Jan. 23, 1886.

341,615. Gas-Heated Bakers' Oven. William H. Thompson, Leeds, County of York, England, assignor to the Thompson Gas Kiln and Oven Company, New York, N. Y. Filed Feb. 24, 1885.

341,622. Process of Manufacturing Illuminating-Gas. John B. Archer, Washington, D. C. Filed Oct. 9, 1885.

341,624. Apparatus for Manufacturing Illuminating-Gas. John B. Archer, Washington, D. C. Filed Aug. 6, 1885.

341,625. Combined Gas and Steam Generator. John B. Archer, Washington, D. C. Filed April 23, 1885.

341,627. Apparatus for Generating Gas or Vapor. John B. Archer, Washington, D. C. Filed March 12, 1885.

341,629. Apparatus for Generating Vapor or Gas. John B. Archer, Washington, D. C. Filed March 12, 1885.

341,776. Gas-Pressure-Regulating Valve. Levi Shook, Pittsburg, Pa. Filed March 13, 1886.

341,777. Portable Gas-Holder. George M. Stephen, Galesburg, Ill. Filed Oct. 12, 1885.

341,841. Gas-Test Gage. Elliott P. Gleason, Brooklyn, N. Y. Filed Feb. 8, 1886.

May 18.

341,882. Electric Gas-Lighting Apparatus. Asa F. Cogswell, William Young, and John R. Haldeman, Kansas City, Mo. Filed March 3, 1884.

341,934. Gas-Engine. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Sept. 23, 1885.

341,935. Method of Operating Gas-Engines. Lewis H. Nash, Brooklyn, assignor to the National Meter Company, New York, N. Y. Filed Sept. 23, 1885.

342,139. Self-Closing Gas-Burner. William W. Sherman, San Francisco, Cal. Filed Jan. 12, 1886.

342,143. Means for Gas-Distribution. Roland H. Smith and William F. Smith, Pittsburg, Pa. Filed Dec. 9, 1885.

342,232. Gas Cooking-Stove. John Somerville, Bankside, Southwark, and William H. Y. Webber, Forest Hill, County of Surrey, England. Filed March 18, 1885.

May 25.

342,592. Device for Cleaning Gas-Burners. James H. Finck, Boston, Mass. Filed March 6, 1886.

342,659. Pipe-Joint for Gas-Mains. George Westinghouse, Jr., Pittsburg, Pa. Filed March 1, 1886.

342,722. Process of and Apparatus for Distilling Ammonia. William C. Wren, Brooklyn, assignor to the Consolidated Refrigerating Company, New York, N. Y. Filed Feb. 20, 1886.

June 1.

343,122. Gas-Furnace for Melting Metal in Crucibles. Henry H. Garrett, Pittsburg, Pa., assignor of one-half to Ralph Bagaley, same place. Filed Nov. 27, 1885.

343,142. Regenerative Gas-Lamp. Henry C. Scotchmer and John Young, Chicago, Ill. Filed May 14, 1885.

June 8.

343,282. Automatic Safety Gas-Burner. James F. Strong and John H. J. Haines, Flushing, N. Y. Filed May 2, 1885.

343,344. Gas-Lamp. George E. Slaughter, Atlantic, Iowa. Filed Feb. 20, 1886.

343,359. Gas-Regulator. Michael J. Berry, Bradford, Pa. Filed April 21, 1886.

343,524. Method of Manufacturing Heating and Illuminating Gas. William F. M. McCarty, Philadelphia, Pa., assignor to Jane Logan, Hagerstown, Md., and Adolph Ohl and Bernard C. Lauth, Philadelphia, Pa. Filed Nov. 25, 1885.

343,525. Apparatus for the Manufacture of Gas. William F. M. McCarty, Philadelphia, Pa., assignor to Jane Logan, Hagerstown, Md., and Adolph Ohl and Bernard C. Lauth, Philadelphia, Pa. Filed Nov. 30, 1885.

June 15.

343,708. Retort Gas-Lamp. George H. Gregory, Chicago, Ill. Filed May 25, 1885.

343,744. Gas-Engine. Stephen Wilcox, Brooklyn, N. Y. Filed Oct. 12, 1885.

343,745. Gas-Engine. Stephen Wilcox, Brooklyn, N. Y. Filed Nov. 14, 1885.

June 22.

343,995. Gas Apparatus. Erazm. J. Jerzmanowski, New York, N. Y. Filed March 31, 1882.

343,996. Process of Producing Illuminating-Gas. Erazm. J. Jerzmanowski, New York, N. Y. Filed July 19, 1883.

344,060. Center Seal for Gas-Works. Gleason F. Starkweather, Evanston, assignor to Nathaniel S. Bouton, Chicago, Ill. Filed Oct. 2, 1885.

344,131. Automatic Gas-Regulator. James M. Palmer, Boston, Mass. Filed Sept. 10, 1885. Renewed May 3, 1886.

344,144. Center Seal for Gas-Works. Gleason F. Starkweather, Evanston, assignor to Nathaniel S. Bouton, Chicago, Ill. Filed Oct. 2, 1885.

344,195. Gas-Lamp. Henry G. O'Neill, Cincinnati, Ohio, assignor to the Platinum Light Company, same place. Filed March 29, 1886.

June 29.

344,385. Gas-Combustion Apparatus. Christian Konold and William H. Hays, Pittsburg, Pa. Filed Sept. 2, 1885.

344,440. Gas-Engine. John H. Clark, Boston, Mass. Filed Nov. 9, 1885.

344,510. Automatic Cut-Off for Gas-Burners. Benjamin D. Warner and Augustus Pelisse, Newark, N. J. Filed Dec. 29, 1885.

344,616. Apparatus for and Process of Supplying Air and Gas. George E. Benninghoff, Kendall Creek, Pa. Filed Feb. 6, 1886.

344,654. Gas-Regulator. Harry L. Harris and Willard L. Harris, San Francisco, Cal. Filed March 15, 1886.

344,701. Means for Detecting and Carrying Off Leakage from Gas-Mains. George Westinghouse, Jr., Pittsburg, Pa. Filed Oct. 12, 1885.

344,723. Pipe-Coupling for Gas-Mains. Frederick Crocker, Olean, N. Y., assignor of one-half to Charles D. Robbins, Burgettstown, Pa. Filed Jan. 28, 1886.

July 6.

344,808. Gas-Burner. William T. Bradberry, Allegheny, Pa. Filed Dec. 11, 1885.

344,900. Gas-Burner. George Galland and Emile Groux, Wilkesbarre, Pa. Filed Jan. 2, 1886.

344,916. Automatic Gas Cut-Off. Charles Leech, Oakland, Cal. Filed Nov. 17, 1885.

344,986. Gas-Burner for Cooking Purposes. Thomas Redmayne, Sheffield, County of York, England. Filed Aug. 3, 1885.

344,987. Gas-Burner for Cooking Purposes. Thomas Redmayne, Sheffield, County of York, England. Filed Feb. 10, 1886.

344,989. Gas-Regulator. William C. Rossney, Hyde Park, assignor to Charles A. Shaw, Boston, Mass. Filed March 9, 1885.

344,990. Gas-Regulator. William C. Rossney, Hyde Park, assignor to Charles A. Shaw, Boston, Mass. Filed Feb. 13, 1886.

345,132. Apparatus for Purifying Gases. Leven S. Goodrich, Warner, Tenn. Filed Sept. 29, 1885.

July 13.

345,368. Automatic Gas-Governor. Thomas E. Connelly, Pittsburg, Pa., assignor of one-half to John S. Connelly, New York, N. Y. Filed Nov. 21, 1885.

345,369. Gas-Governor. John S. Connelly, Brooklyn, N. Y., assignor of one-half to Thomas E. Connelly, Pittsburg, Pa. Filed Dec. 8, 1885.

345,437. Gas Retort and Furnace. Alonzo M. Mace, Needham, Mass. Filed March 15, 1884.

345,499. Gas-Burner. Thomas Gordon, Philadelphia, Pa. Filed Dec. 23, 1885.

345,596. Gas-Engine. Etienne J. J. Lenoir, Paris, France. Filed Jan. 6, 1886.

345,649. Process of and Apparatus for Manufacturing Heating and Illuminating Gas. James Roberts, New York, N. Y., assignor to the Acme Liquid Fuel Company, of New York. Filed Feb. 23, 1886.

July 20.

345,980. Process of Treating Natural Gas to Convert it into Illuminating-Gas. John McKay, Titusville, Pa. Filed May 29, 1886.

345,998. Gas-Engine. Reuben F. Smith, Atchison, Kan. Filed Oct. 27, 1885.

July 27.

346,297. Gas-Heating Furnace. John N. MacGonigle, Oil City, Pa. Filed Dec. 4, 1884. Renewed April 3, 1886.

346,301. Gas-Retort Furnace. George A. McIlhenny, Washington, D. C. Filed April 30, 1885.

346,374. Regulator for Gas-Engines. Ernst Körting, Hanover, Prussia, Germany. Filed March 10, 1886.

346,402. Price and Quantity Register for Gas-Meters. James S. De Palos, New York, N. Y. Filed Sept. 17, 1885.

346,403. Pressure-Regulator. James S. De Palos, New York, N. Y. Filed Dec. 24, 1885.

Reissue.

10,750. AIR AND GAS-ENGINE. Stephen Wilcox, Brooklyn, N. Y. Filed May 26, 1886. Original No. 332,312, dated Dec. 15, 1885.

August 3.

346,478. BALL-AND-SOCKET JOINT FOR WATER AND GAS PIPES. Alba L. Holmes, Grand Haven, Mich. Filed April 16, 1886.

346,508. REGENERATOR GAS-FURNACE. William H. Smith, Canton, Ohio. Filed July 21, 1885.

346,533. GAS-LIGHTING DEVICE. Charles H. Crockett and Chancellor C. Allen, Boston, Mass. Filed Jan. 6, 1886.

346,687. GAS-MOTOR ENGINE. Horace Robinson, Manchester, County of Lancaster, England. Filed June 19, 1884.

August 10.

347,137. GAS-ENGINE PUMP. Fenner B. Taylor, Washington, D. C. Filed March 11, 1886.

347,155. GAS-BURNER. Edward Bourne, Allegheny, Pa. Filed Dec. 31, 1885.

August 17.

347,469. GAS-ENGINE. John H. Clark, Boston, assignor to Oliver Ames, Easton, Mass. Filed Sept. 12, 1885.

347,561. GAS-STOVE. Clarence L. Bisbee, Brooklyn, N. Y. Filed Dec. 7, 1885.

347,603. GAS-ENGINE. James Hodgkinson and John H. Dewhurst, Manchester, County of Lancaster, England. Filed May 19, 1886.

347,622. REGENERATIVE GAS-LAMP. Charles M. Lungren, New York, N. Y. Filed Feb. 20, 1886.

347,656. GAS-ENGINE. Reuben F. Smith, Pleasant Hill, Ala. Filed April 8, 1886.

347,693. PROCESS OF DECOMPOSING AND CARBURETTING NATURAL GAS. John M. Critchlow, Beaver Falls, Pa. Filed Dec. 17, 1885.

347,703. REGENERATIVE GAS-FURNACE. Emile Fourcault and Ernst Jacques, Dampremy, Belgium. Filed Oct. 7, 1885.

August 24.

347,840. GAS-REGULATOR. John Stubbe, Pittsburg, Pa., assignor of two-thirds to George T. Oliver and Cadwallader Evans, both of same place. Filed May 7, 1886.

348,137. ELEVATING DEVICE FOR COVERS OF GAS-PURIFIERS. George W. Nock, Philadelphia, Pa., assignor of one-half to James R. Floyd, New York, N. Y. Filed Jan. 23, 1886.

348,172. GAS-PRESSURE REGULATOR. Charles Ruprecht, Cleveland, Ohio. Filed July 3, 1886.

348,178. Process of and Apparatus for Manufacturing Heating-Gas. Asa W. Wilkinson, New York, N. Y., assignor of one-half to Edward S. T. Kennedy, same place. Filed April 24, 1886.

Reissue.

10,759. Gas-Engine. Gottlieb Daimler, Cannstadt, Würtemberg, Germany. Filed June 7, 1886. Original No. 313,923, dated March 17, 1885.

August 31.

348,338. Gas-Pressure Regulator. Richard Pickering, Cleveland, Ohio. Filed April 19, 1886.

348,389. Gas-Regulator. Archibald Ford, San Francisco, Cal. Filed May 12, 1886.

September 7.

348,832. Apparatus for the Purification of Gas. Alexander Delaney and William Simpkin, Richmond, Va. Filed Nov. 27, 1885.

348,897. Regulating-Valve for Gas-Burners. Millard F. Elliott, Philadelphia, Pa. Filed June 12, 1886.

348,913. Gasometer. Otto Intze, Aachen, Prussia, Germany. Filed June 13, 1885.

348,917. Carburetter to be Used in the Manufacture of Water-Gas. Frederick C. Kniese, Baltimore, Md. Filed April 8, 1886.

September 14.

348,951. Joint for Gas-Mains. Edmund C. Converse, Pittsburg, Pa. Filed Feb. 16, 1886.

348,998. Gas-Engine. James F. Place, New York, N. Y. Filed Feb. 3, 1886.

348,999. Gas-Engine. James F. Place, New York, N. Y. Filed Feb. 17, 1886.

349,109. Means for Operating the Stop-Cocks of Gas-Meters. Leon Lenaerts, Brussels, Belgium. Filed Oct. 5, 1885.

349,211. Method of and Apparatus for Carburetting and Mixing Gas and Air. George R. Cottrell, New York, N. Y. Filed Jan. 25, 1886.

September 21.

349,369. Petroleum and Gas-Engines. Johannes Spiel, Berlin, Germany. Filed May 4, 1886.

349,464. Gas-Engine. Johannes Spiel, Berlin, Germany. Filed April 7, 1885.

349,489. Oscillating Gas-Meter. Anson F. Fisher, Chico, Cal., assignor of two-thirds to Allen Henry and A. M. Barley, same place. Filed Feb. 27, 1886.

349,533. Electric Gas-Burner. Adolph T. Smith, New York, N. Y. Filed Feb. 18, 1886.

September 28.

349,858. Gas-Engine. Andrew L. Riker, New York, N. Y. Filed July 15, 1886.

350,077. Gas-Motor Engine. Nicolaus A. Otto, Cologne-on-the-Rhine, assignor to the Gas-Motoren-Fabrik-Deutz, Deutz-on-the-Rhine, Germany. Filed May 27, 1886.

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Pittsburg, Pa. ..... Weekly, $3 "

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FRED. H. SHELTON, Philadelphia, Pa.	WM. A. WOOD, Boston, Mass.
W. P. KNOWLES, Richmond, Va.	WALTON CLARK, Philadelphia, Pa.

Ex-officio, Junior Past President:

ALTEN S. MILLER ..... BALTIMORE, MD.

PAST PRESIDENTS.

*Charles Roome 1873–79
*William H. Price 1880–1881
Andrew Hickenlooper 1882
*Theobald Forstall 1883
*William A. Stedman 1884
*Eugene Vanderpool 1885
Austin C. Wood 1886
Malcolm S. Greenough 1887
Thomas Turner 1888
Alpheus B. Slater 1889
Emerson McMillin 1890
John P. Harbison 1891
William Henry White 1892
Arthur E. Boardman 1893
William H. Pearson 1894
Walton Clark 1895
C. J. R. Humphreys 1896
Chas. H. Nettleton 1897
J. B. Crockett 1898
Alex. C. Humphreys 1899
George G. Ramsdell 1900
Edward G. Pratt 1901
William R. Beal 1902
Alten S. Miller 1903

PAST SECRETARIES.

Henry Wurtz 1873
*Peter E. Demill 1874
*Charles Nettleton 1875–79
William Henry White 1880–83
C. J. R. Humphreys 1884–91
A. B. Slater, Jr 1892–96

* Deceased.

MEMBERS

OF THE

AMERICAN GAS LIGHT ASSOCIATION.

1903–1904.

(The date with each name is that of election to membership.)

HONORARY MEMBERS.

Barker, Forrest E. October 27, 1896.
Chairman of Massachusetts Board of Gas and Electric Light Commissioners, Boston, Mass., State House, Room 145.

Bunte, Dr. Hans. October 16, 1901.
Geheimer Hofrat, Professor Grossherzogliche-Badischen Technischen Hochschule, Generalsekretair des Deutschen Vereins von Gas-und Wasserfachmännern, Karlsruhe in Baden, Germany, Nowacksanlage 13.

Chandler, C. F. October 21, 1875.
51 East 54th street, New York, N. Y., Professor Columbia University and Chemist to New York Gas Light Co.

Foote, Allen R. October 17, 1894.
625 Home Insurance Building, Chicago, Ill., Editor of *Public Policy*.

King, William. October 18, 1877.
Duke street, Liverpool, England, Engineer of Liverpool United Gas Light Co.

Livesey, Sir George T. October 20, 1897.
M. I. C. E., etc., Chairman South Metropolitan Gas Co., Old Kent Road, London, England.

Love, E. G. October 20, 1886.
122 Bowery, New York, N.Y., Gas Examiner of New York City.

Oechelhaeuser, W. von. October 16, 1901.
Dessau, Germany, General Director of the German Continental Gas Association, Past President of the Deutschen Vereins von Gas-und Wasserfachmännern.

Slater, A. B. October 15, 1902.
251 Rhodes street, Providence, R. I., P. O. Box 1260.

Vautier, Th. October 17, 1900.
Le Président du Congrès International de l'Industrie du Gaz en 1900, 46 rue Centrale, Lyon (Rhône), France.

Welsbach, Dr. Carl Ritter Auer Von. October 17, 1900.
IV. Wiedner Hauptstrasse No. 69, Vienna, Austria.

Woodall, Corbett. October 20, 1897.
M. I. C. E., etc., Palace Chambers, Westminster, London, England, Consulting Engineer.

ACTIVE MEMBERS.

Adams, Charles F. October 17, 1894.
Cor. Fifth and Yawhill streets, Portland, Oregon, President Portland Gas Co.

Adams, Henry C. October 20, 1886.
224 South Third street, Philadelphia, Pa., Vice-President of Westmoreland Coal Co.

Addicks, Frederick P. October 15, 1890.
52 Broadway, New York, N. Y.

Addicks, J. Edward. October 20, 1886.
Wilmington, Del.

Addicks, Walter R. October 15, 1890.
4 Irving place, New York, N. Y., Vice-President of Consolidated Gas Co. of New York.

Africa, Walter G. October 21, 1891.
39 Hanover street, Manchester, N. H., Treasurer and Superintendent of People's Gas Light Co.

Aldrich, F. B. October 15, 1902.
200 West Market street, Pottsville, Pa., General Manager of Pottsville (Pa.) Gas Co., Schuylkill Haven (Pa.) Gas and Water Co., Schuylkill County (Pa.) Gas Co., Bath (N. Y.) Electric and Gas Co., and Easton (Md.) Light and Fuel Co.

Aldrich, W. A. October 19, 1898.
1517 First avenue, Spokane Falls, Washington, General Manager Spokane Falls Gas Co.

Allen, Wm. H. October 16, 1901.
575 Broad street, Newark, N. J., Commercial Agent of Public Service Corporation of New Jersey.

Allyn, G. E. October 21, 1903.
15 Beacon avenue, Providence, R. I., Superintendent of Distribution of the Providence Gas Co.

Allyn, Horace A. October 16, 1901.
Third street, East Cambridge, Mass., Superintendent of Cambridge Gas Light Co.

Ammon, Harry T. October 15, 1902.
Wyandotte, Mich., Manager of Wyandotte Light and Fuel Co.

Anderson, William C. October 18, 1899.
23 Boulevard des Italiens, Paris, France, Assistant to the European Representative of the Stanley Instrument Co.

Andrews, J. Charles. October 19, 1898.
405 17th street, Denver, Col., care Denver Gas and Electric Co.

Apperson, Richard D. October 16, 1901.
723 Main street, Lynchburg, Va., President and General Manager of the Lynchburg Traction and Light Co.

Armington, James H. October 19, 1881.
Riverside, R. I., P. O. Box 41.

Armington, William A. October 19, 1892.
49 Wall street, New York, N. Y., Superintendent of Construction, Consolidated Industries Co.

Arthur, F. M. October 18, 1899.
1615 N. Ninth street, Philadelphia, Pa., Superintendent Spring Garden District of the Philadelphia Gas Works, The United Gas Improvement Co.

Baehr, William A. October 17, 1900.
716 Locust street, St. Louis, Mo., Engineer of Laclede Gas Light Co.

Bailey, W. Frank. October 21, 1903.
Wilmington, Del., Superintendent of Distribution of the Wilmington Gas and Electric Co.

Bailey, William. October 18, 1898.
216 High avenue West, Oskaloosa, Iowa, Manager of the Oskaloosa Gas Co.

Baldwin, Wareham S. October 21, 1903.
Detroit, Mich., Superintendent Station B, Detroit City Gas Co.

Ball, James. October 21, 1903.
Philadelphia, Pa., Assistant Treasurer of The United Gas Improvement Co.

Barclay, V. B. October 21, 1903.
Newport News, Va., Superintendent of the Newport News Gas Co.

Barret, A. H. October 16, 1878.
Louisville, Ky., Engineer Louisville Gas Co.

Barrett, W. E. October 16, 1895.
Scranton, Pa., General Manager Scranton Gas and Water Co.

Barthold, W. H. October 15, 1902.
Grand Rapids, Mich., Engineer of Grand Rapids Gas Light Co.

Bartlett, Edward L. October 20, 1886.
McHenry and Scott streets, Baltimore, Md., P. O. Box 960, Mechanical Engineer of Bartlett, Hayward & Co.

Battin, H. S. October 19, 1898.
Broad and Arch streets, Philadelphia, Pa., Assistant Superintendent of Works, The United Gas Improvement Co.

Battin, Isaac. October 15, 1873.
1224 Farnum street, Omaha, Neb., Treasurer and Engineer of the Omaha Gas Co.

*Battin, William I. October 19, 1898. October 18, 1899.
635 West 62d street, Chicago, Ill., Gas Engineer.

* First date is that of election to membership in the Association; second that of transfer from Associate to Active membership.

Baumgardner, John H. October 15, 1879.
129 North Queen street, Lancaster, Pa.

Baumgardner, Thomas. October 15, 1902.
Belmar, N. J., Superintendent of Coast Gas Co.

Baxter, Isaac C. October 18, 1882.
Wayne County Bank, Detroit, Mich., President Bucyrus, O., Gas and Electric Light Co.

Baxter, Robert. October 19, 1881.
Halifax, N. S., P. O. Box 373, Manager of People's Heat and Light Co., Limited.

Baxter, William H. April 16, 1873.
201 Sycamore street, Petersburg, Va., P. O. Box 34, Superintendent of Petersburg Gas Light Co.

Bayly, C. Clay. October 17, 1900.
26th and G streets, Washington, D. C., care of Washington Gas Light Co.

Beadenkopf, George. October 21, 1891.
5 and 7 W. Baltimore street, Baltimore, Md., Engineer of Consolidated Gas Co.

Beadle, A. B. October 21, 1891.
528 Bourse Building, Philadelphia, Pa., Gas Engineer.

Beal, Thaddeus R. October 21, 1891.
Poughkeepsie, N. Y., General Manager of the Poughkeepsie Light, Heat and Power Co.

Beal, William R. May 13, 1874.
1 West 121st street, New York, N. Y., Chairman of Board of Central Union Gas Co.

Beck, George W. October 15, 1902.
455 Market street, Sunbury, Pa., Superintendent of the Sunbury Gas Co.

Bell, Ernest William. October 17, 1900.
245 East 61st street, Chicago, Ill.

Benner, Henry W. October 18, 1899.
Address unknown.

Bennett, Charles W. October 15, 1902.
27 E. Front street, Red Bank, N. J., Superintendent of the Consolidated Gas Co. of New Jersey.

Benson, Fred. S. October 20, 1875.
Kent avenue, cor. of Cross street, Brooklyn, N. Y., Chief Engineer Eastern Division of the Brooklyn Union Gas Co.

Bertrand, P. A. October 21, 1903.
Springfield, Mo., General Manager of the Springfield Gas and Electric Co.

Bigelow, Arthur F. October 19, 1892.
540 Hamilton street, Allentown, Pa., Superintendent of Allentown Gas Co.

Bissell, West. October 20, 1897.
Cor. Sixth and Provost streets, Jersey City, N. J., Assistant Engineer of the Public Service Corporation of N. J., Gas Department, Hudson County Division.

Blake, S. N. October 16, 1901.
501 Realty Building, Elmira, N. Y., President Norwich (N. Y.) Gas and Electric Co. and Treasurer of Dansville Gas and Electric Co.

Blinks, Walter M. October 17, 1900.
Kalamazoo, Mich., care of General Gas Light Co.

Blodget, Charles W. October 15, 1884.
43 West 37th street, New York, N. Y.

Blowers, Frank W. October 15, 1902.
147 South Burdick street, Kalamazoo, Mich., Secretary and General Manager of the Kalamazoo Gas Co.

Boardman, Arthur E. October 15, 1884.
44 Broad street, New York, N. Y., Consulting Engineer.

Boardman, A. J. October 27, 1896.
Roberts Building, Tampa, Fla., Manager of Tampa Gas Co.

Bodine, Samuel T. October 20, 1886.
Broad and Arch streets, Philadelphia, Pa., Second Vice-President and General Manager of The United Gas Improvement Co.

Borgner, Cyrus. October 13, 1880.
23d street, above Race, Philadelphia, Pa., Manufacturer of Fire Brick and Clay Retorts.

Bowen, William S. October 15, 1890.
Address unknown.

Bradley, Fred. L. October 16, 1889.
302 East 99th street, New York, N. Y., Superintendent of 99th street Station, Consolidated Gas Co.

Bradley, Savery. October 21, 1903.
Atlantic City, N. J., President of the Atlantic City Gas and Water Co.

Bradley, William H. May 12, 1875.
4 Irving place, New York, N. Y., Chief Engineer of Consolidated Gas Co. of New York.

Brainard, Don C. October 21, 1903.
Carthage, Mo., General Manager of the Carthage Light, Heat and Power Co.

Braine, John H. October 21, 1903.
37 Lombardy street, Newark, N. J., Superintendent of Distribution, Newark District, Public Service Corporation of New Jersey.

Branch, A. H. October 19, 1892.
110 North Broadway, Oklahoma, O. T., P. O. Box 898, President and General Manager of Oklahoma Gas and Electric Co.

Bredel, Frederick A. October 21, 1885.
405 Keene street, Milwaukee, Wis., President of Fred. Bredel Co.

Britton, John A. October 16, 1895.
Oakland, Cal., P. O. Box 128, President and General Manager of Oakland Gas Light and Heat Co.

Brown, Ernest C. October 19, 1887.
280 Broadway, New York, N. Y., Publisher of *Progressive Age*.

Brown, Rezeau B. October 27, 1896.
182 Wisconsin street, Milwaukee, Wis., Engineer Milwaukee Gas Light Co.

Brown, W. O. October 16, 1901.
Newton, N. J.

Bruce, Howard. October 15, 1902.
4 Irving place, New York, N. Y., Engineer of Construction of Consolidated Gas Company of New York.

Brundrett, E. L. October 18, 1899.
1401 Arch street, Philadelphia, Pa., P. O. Box 1564, General Auditor of The United Gas Improvement Co.

Bryant, Charles F. October 21, 1903.
Bridgeport, Conn., Auditor of the Connecticut Railway and Lighting Co.

Buck, David, Jr. October 18, 1899.
Taylor Hotel, Main street, Coatesville, Pa., P. O. Box 540, Superintendent of Coatesville Gas Co.

Buck, H. M. October 19, 1898.
Waukesha, Wis., Superintendent of Waukesha Gas and Electric Co.

Buckman, James. October 15, 1890.
S. E. corner 8th and Green streets, Philadelphia, Pa., Manager Bristol Gas Light Co. of Bristol, Pa.

Bunker, Theodore. October 21, 1903.
418 Federal street, Camden, N. J., Superintendent of Distribution South Jersey Division, Public Service Corporation of New Jersey.

Burgi, Herman. October 15, 1902.
1173 East 139th street, New York, N. Y., Superintendent of Central Union Gas Co.

Burke, James E. October 16, 1895.
Princeton, N. J., Lock Box 157, Secretary and Treasurer of the Princeton Gas Light Co.

Burrage, Albert C. October 20, 1897.
24 West street, Boston, Mass., President Boston, Roxbury, Dorchester, South Boston and Bay State (of Mass.) Gas Light Companies.

Burrage, Charles D. October 16, 1901.
85 Ames Building, Boston, Mass., Vice-President and Secretary of the Boston Gas Light Co., South Boston Gas Light Co., Roxbury Gas Light Co. and the Bay State Gas Co.

Burrows, C. E. October 17, 1900.
8 East Alder street, Walla Walla, Wash., P. O. Box 139, Secretary and General Manager Walla Walla Gas and Electric Co.

Bush, John F. October 17, 1900.
1124 St. Paul street, or 242 Powers Block, Rochester, N. Y., Secretary Brockport Gas Light Co., Brockport, N. Y.

Bush, Robert W. October 19, 1892.
12th street and Gowanus Canal, Brooklyn, N. Y., Engineer of Metropolitan Works, Brooklyn Union Gas Co.

Butler, Matthew W. October 21, 1903.
2108 N. 20th street, Philadelphia, Pa., Engineer of the Pennsylvania Gas Improvement Co.

Butterworth, C. W. October 16, 1901.
29 Kingman street, St. Albans, Vt., P. O. Box 229, Superintendent of St. Albans Gas Light Co.

Butterworth, Irvin. October 16, 1889.
230 Woodward avenue, Detroit, Mich., President, Secretary and General Manager of the Detroit City Gas Co.

Byers, C. A. October 18, 1894.
Toledo, Ohio, Consulting Engineer of Bristol Gas Light Co.

Byrne, Edward J. October 21, 1903.
Fifth and Hoyt streets, Brooklyn, N. Y., Superintendent of the Brooklyn Union Gas Co.

Byrne, Thomas E. October 18, 1882.
First avenue and 55th street, Brooklyn, N. Y., Engineer and Superintendent of the Kings County Gas and Illuminating Co.

Cabot, John. October 19, 1884.
1412-1416 Adams street, Hoboken, N. J., Manufacturer of Trays for Gas Works.

Callahan, W. P. October 19, 1881.
901 East 3d street, Dayton, Ohio, Director of Dayton Gas Light and Coke Co.

Callanan, John M. October 18, 1899.
517 Market street, Chester, Pa., Superintendent of the Suburban Gas Co. of Philadelphia, Chester Branch.

Callender, Elbert P. October 17, 1894.
42 Pine street, New York, N. Y., Editor of *American Gas Light Journal*.

Campbell, Alexander James. October 15, 1902.
Norwich, Conn., General Manager of the Norwich Gas and Electric Co.

Carpender, William. October 27, 1896.
44 Pine street, New York, N. Y.

Carter, Robert A. October 15, 1902.
4 Irving place, New York, N. Y., Controller of the Consolidated Gas Co. of New York.

Case, Edwin R. October 15, 1902.
15 Exchange place, Jersey City, N. J., President of the Fidelity Gas Co., Hoosick Falls, N. Y.; Monroe County Gas Co., Stroudsburg, Pa.

Case, Willard E. October 16, 1901.
Auburn, N. Y., Vice-President of American Light and Traction Co.

Cashion, Edwin M. October 15, 1902.
Glens Falls, N. Y., Superintendent of the Glens Falls Gas and Electric Light Co.

Cathels, Edmund. October 27, 1896.
34 Plain street, Providence, R. I., Engineer of Providence Gas Co.

Cathels, Wm. M. October 19, 1898.
48 George street, Brantford, Ont., Canada, P. O. Box 270, Manager Brantford Gas Co., Limited.

Chandler, Frank E. October 16, 1901.
Medford, Mass., President and General Manager of Malden and Melrose Gas Light Co.

Childs, Arthur E. October 16, 1901.
131 State street, Boston, Mass., President of Light, Heat and Power Corporation.

Chollar, Byron E. October 17, 1888.
714 Locust street, St. Louis, Mo.

Clabaugh, G. W. October 16, 1901.
1224 Farnum street, Omaha, Neb., Secretary of the Omaha Gas Co.

Clahan, John J. October 19, 1898.
68 West Tupper street, Buffalo, N. Y., Superintendent of People's Gas Light and Coke Co.

Clark, John A., Jr. October 15, 1902.
258 North Park street, E. Orange, N. J., Superintendent of Distribution of the Orange, Montclair and Summit districts of the Public Service Corporation of N. J., Gas Department.

Clark, John C. D. October 21, 1903.
716 Locust street, St. Louis, Mo., Superintendent of New Business Department of the Laclede Gas Light Co.

Clark, Walton. October 15, 1884.
Broad and Arch streets, Philadelphia, Pa., P. O. Box 1564, General Superintendent of The United Gas Improvement Co.

Clarke, George S. October 17, 1888.
10th and Walnut streets, Kansas City, Mo., Superintendent of Kansas City, Mo., Gas Co.

Clary, Edward D. October 21, 1891.
914 North 6th street, Burlington, Iowa, Secretary and Superintendent of Burlington Gas Light Co.

Clements, W. B. October 15, 1902.
Mount Vernon, N. Y., Auditor of the Westchester Lighting Co.

Cline, W. B. October 19, 1898.
645 South Hill street, Los Angeles, Cal., President and General Manager of Los Angeles Lighting Co.

Coate, P. S. October 21, 1903.
Chatham, Ontario, Canada, Manager and Secretary-Treasurer of the Chatham Gas Co., Limited.

Coates, John R. October 17, 1894.
23 Sparks street, Ottawa, Canada, President of Ottawa Gas Co.

Cobb, Bernard C. October 15, 1902.
Saginaw, Mich., Secretary and General Manager of the Saginaw City Gas Co.

Cocke, J. T. Bowdoin. October 20, 1897.
2104 First avenue, Birmingham, Ala., Gas Engineer with Ford, Bacon & Davis, New York, N. Y.

Coffin, Charles Francis. October 15, 1902.
Watertown, N. Y., General Manager Watertown Gas Light Co.

Coffin, John A. October 20, 1886.
Duncan street, Gloucester, Mass., Superintendent and Agent of Gloucester Gas Light Co.

Coggshall, Henry F. May 13, 1874.
374 Main street, Fitchburg, Mass., P. O. Box 633, General Manager and Treasurer of Fitchburg Gas and Electric Light Co.

Cole, George M. October 15, 1902.
Plattsburgh, N. Y., Manager of the Plattsburgh Light, Heat and Power Co.

Coles, James M. October 15, 1902.
619 Mattison avenue, Asbury Park, N. J., P. O. Box 2000, Superintendent of the Consolidated Gas Co. of New Jersey.

Collins, Charles R. October 15, 1890.
1425 First avenue, Seattle, Wash., Consulting Engineer of Citizens' Light and Power Co.

* Collins, David J. October 17, 1894. October 16, 1901.
Broad and Arch streets, Philadelphia, Pa., Sales Agent of The United Gas Improvement Co.

Collins, Henry P. October 17, 1900.
Little Falls, N. Y., General Superintendent of Herkimer County Light and Power Co.

Collins, John. October 21, 1891.
180 Main street, Newton, N. J., P. O. Box 36, Superintendent of the Newton Gas and Electric Co.

Combs, Roger B. October 21, 1903.
Broad and Arch streets, Philadelphia, Pa., Engineer with The United Gas Improvement Co.

Congdon, Richard Cromwell. October 15, 1902.
Record street, Frederick, Md., Manager of Frederick Gas Co.

Cooke, Alfred S. October 18, 1899.
40 Wall street, New York, N. Y., Auditor of the United Gas and Electric Co.

Cooper, William H. October 18, 1899.
33 Market street, Amsterdam, N. Y., Superintendent of Chuctanunda Gas Light Co.

Copley, I. C. October 21, 1903.
Aurora, Ill., President, Treasurer and Manager of the La Grange Gas Co., Joliet Gas Light Co., and Fox River Light, Heat and Power Co.

Corbett, Charles H. October 18, 1882.
428 Lafayette avenue, Brooklyn, N. Y., P. O. Station G, Vice-President of Continental Iron Works.

Cosgrove, W. L. October 20, 1886.
Alabama and Broad streets, Atlanta, Ga., Secretary of Atlanta Gas Light Co.

Cowdery, Edward G. October 21, 1885.
716 Locust street, St. Louis, Mo., Vice President and General Manager of the Laclede Gas Light Co.

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* First date is that of election to membership in the Association ; second that of transfer from Associate to Active membership.

Coyle, Patrick. October 19, 1881.
27 Arlington avenue, Charlestown, Mass., General Superintendent of Charlestown Gas and Electric Co.

Crafts, H. C. October 16, 1901.
212 Main street, Northampton, Mass., Superintendent of Northampton Gas Light Co.

Cressler, Alfred D. October 18, 1882.
Calhone and Murray streets, Fort Wayne, Ind., President and General Manager of Kerr-Murray Manufacturing Co.

Cresson, B. F. October 21, 1903.
Easton, Pa., Secretary of the Easton Gas and Electric Co.

Crisfield, James A. P. October 15, 1890.
Broad and Arch streets, Philadelphia, Pa., Engineer of Design of The United Gas Improvement Co.

Crockett, Joseph B. October 17, 1883.
415 Post street, San Francisco, Cal.

Cross, Philip. October 19, 1898.
405 17th street, Denver, Col., Manager New Business Department the Denver Gas and Electric Co.

Crowell, Frederick B. October 21, 1903.
38 Thurmond street, Atlanta, Ga., Superintendent of the Atlanta Gas Light Co.

Cummins, John J. October 15, 1902.
Syracuse, N. Y., Vice-President and Treasurer of the Syracuse Lighting Co.

Curley, Thomas. October 15, 1879.
827 Market street, Wilmington, Del., Superintendent of Wilmington Coal Gas Co.

Curran, G. W. October 16, 1901.
N. W. corner Broad and Arch streets, Philadelphia, Pa., Assistant General Auditor of The United Gas Improvement Co.

Curtis, George W. October 21, 1903.
Camden, N. J., Superintendent of Manufacturing, South Jersey Division, Public Service Corporation of New Jersey.

Curtis, Samuel Philip. October 20, 1897.
222 South 3d street, Philadelphia, Pa., General Superintendent of the American Gas Co.

Daly, Augustin J. October 15, 1902.
2659 Adams street, St. Louis, Mo., Superintendent of Service Department of the Laclede Gas Light Co.

Daly, David R. October 21, 1885.
Green and Essex streets, Jersey City, N. J., Vice-President and Treasurer of J. H. Gautier & Co.

Danforth, George C. October 15, 1902.
Independence, Mo., President of the Independence Gas and Coke Co.

Daniels, John M. October 15, 1890.
1330 Main street, Columbia, S. C., Superintendent and Agent of the Columbia Gas Light Co.

Davidson, Rolland A. October 21, 1903.
Newburgh, N. Y., General Manager of the Newburgh Light, Heat and Power Co.

Davies, George. October 21, 1903.
155 Railroad avenue, White Plains, N. Y., Superintendent of White Plains District, Westchester Lighting Co.

Davies, H. W. October 17, 1900.
730 Broad street, Keyport, N. J., Manager and Treasurer of the Standard Gas Co.

Davis, Fred. J. October 20, 1875.
Waltham, Mass., Constructing Engineer of Davis & Farnum Mfg. Co., Waltham, Mass.

Davis, H. L. October 15, 1902.
Tarrytown, N. Y., Superintendent of the Hudson River Gas and Electric Co.

Davis, J. J. October 15, 1902.
305 Conservative Life Building, Los Angeles, Cal., Superintendent of the United Electric, Gas and Power Co.

Dawes, Beman G. October 19, 1898.
Marietta, Ohio, President and Treasurer Newark Gas Light and Coke Co. and Lansing Gas Light Co.

Dawes, Rufus C. October 17, 1900.
1611 Benson avenue, Evanston, Ill., President and Treasurer Northwestern Gas Light and Coke Co.

Dawson, Geo. H. October 16, 1901.
Springfield, Ill., Assistant Superintendent Springfield Gas Light Co.

Day, Charles F. October 15, 1902.
Springfield, Mass., Superintendent of the Springfield Gas Light Co.

Dell, John. October 21, 1885.
Continental Bank Bldg., 411 Olive street, St. Louis, Mo., President and General Manager Missouri Fire Brick Co.

Dexter, MacDougald. October 15, 1902.
1116 Second avenue, Columbus, Ga., Assistant Superintendent of the Gas Light Co. of Columbus.

Diall, M. N. October 18, 1876.
636 Main street, Terre Haute, Ind., General Manager of Citizens' Gas and Fuel Co.

Dickel, Carl A. October 15, 1902.
961 N. Marshall street, Philadelphia, Pa., Consulting Engineer Bristol Gas Light Co. of Bristol, Pa.

Dickey, Charles H. October 17, 1883.
North and Saratoga streets, Baltimore, Md., P. O. Box 773, President Maryland Meter Co.

Dickey, Robert R. October 19, 1881.
Main and 2d streets, Dayton, Ohio, President of Dayton Gas Light and Coke Co.

Dixon, J. Alfred. October 19, 1892.
160 Broadway, New York, N. Y., General Superintendent of Pintsch Compressing Co.

Dixon, Robert M. October 15, 1890.
160 Broadway, New York, N. Y., 1st Vice-President of the Safety Car Heating and Lighting Co. and the Pintsch Compressing Co.

Doherty, Henry L. October 27, 1896.
40 Wall street, New York, N. Y., General Manager and Chief Engineer of American Light and Traction Co.

Doig, George I. October 21, 1903.
Gainesville, Fla., Superintendent and General Manager of the Gainesville Gas and Electric Light Co.

Dole, Charles E. October 16, 1901.
Bangor, Me., Superintendent of Bangor Gas Light Co.

Dole, Walter S. October 27, 1896.
321 Market street, San Francisco, Cal., Superintendent of the Independent Gas and Power Co.

Donahue, E. J. October 19, 1898.
6th and Provost streets, Jersey City, N. J., Engineer of Gas Department, Hudson County Division, Public Service Corporation of New Jersey.

Doty, Paul. October 27, 1896.
230 Woodward avenue, Detroit, Mich., Secretary and General Manager of Detroit City Gas Co.

Dougherty, Dan J. October 21, 1903.
Jacksonville, Fla., Superintendent of the Citizens' Gas Co.

Douglas, Henry W. October 21, 1891.
211 East Huron street, Ann Arbor, Mich., Manager of Ann Arbor Gas Co.

Douthirt, W. F. October 19, 1898.
N. W. cor. Broad and Arch streets, Philadelphia, Pa., Assistant to Treasurer of The United Gas Improvement Co.

Duke, H. T. October 15, 1902.
625 Drexel Building, Philadelphia, Pa., President of the Hollidaysburg Gas Co.

Duke, Vaughn W. October 15, 1902.
C. E., Hempstead, N. Y., Care of Hempstead Gas Light Co., Superintendent and Engineer of the Hollidaysburg Gas Light Co., and the Pennsylvania Gas Improvement Co.

Dunbar, Carl H. October 18, 1893.
Corner Spring and Milwaukee streets, Elgin, Ill., P. O. Box 178, Superintendent of Elgin American Gas Co.

Dunbar, James W. October 17, 1894.
507 Bank street, New Albany, Ind., Superintendent of United Gas and Electric Co.

Duncan, George F. October 15, 1902.
42 Exchange street, Portland, Me., President of the Galesburg Gas and Electric Light Co.

Dunderdale, Thos. October 19, 1898.
190 Ottawa street, Ottawa, Canada, Superintendent Ottawa Gas Co.

Dunn, Frank S. October 16, 1901.
1131 Broadway, Albany, N. Y., Superintendent of Municipal Gas Co. of Albany.

Dusenberry, J. P. October 16, 1901.
776 Broad street, Newark, N. J., Treasurer of the Public Service Corporation of New Jersey.

Dutton, Lewis R. October 19, 1898.
Wyncote, Pa., P. O. Box 150, Superintendent of the Jenkintown and Cheltenham Gas Co.

Dutton, R. Hayes. October 17, 1900.
15 Baltimore street, Hanover, Pa., P. O. Box 245, Superintendent of the Hanover Gas Co.

Eakin, John W. October 17, 1894.
709 Ohio Levee street, Cairo, Ill., Secretary and Superintendent of Cairo City Gas Co.

Earnshaw, Edward H. October 18, 1899.
22d and Filbert streets, Philadelphia, Pa., Assistant Engineer of Works of the Philadelphia Gas Works, The United Gas Improvement Co.

Eaton, W. M. October 18, 1899.
Grand Rapids, Mich., 2d Vice-President and General Manager of the Grand Rapids Gas Light Co.

Edwards, George B. October 18, 1882.
113 Chambers street, New York, N. Y.

Egner, Frederic. October 16, 1889.
Washington Savings Bank Building, Cor. G and 12th streets, Washington, D. C., Consulting Gas Engineer.

Eichbaum, Frederick H. October 16, 1889.
101 Devisadero street, San Francisco, Cal., Engineer and Superintendent of Pacific Gas Improvement Co.

Eilbeck, Arthur B. October 16, 1892.
40 Wall street, New York, N. Y.

Eisele, John C. October 15, 1902.
164 Market street, Newark, N. J., Treasurer of the Gas Light Co. of the City of New Brunswick.

Elkins, George W. October 20, 1886.
423 Walnut street, Philadelphia, Pa., Manufacturer of Coal Tar Products.

Elles, Edward J. October 18, 1899.
Evansville, Ind., Superintendent of the Evansville Gas and Electric Light Co.

Elliott, W. R. October 15, 1902.
1401 Arch street, Philadelphia, Pa., Assistant Secretary of the Wyandotte Gas Co.

Ellis, John W. October 21, 1903.
Woonsocket, R. I., President and Manager of the Providence Gas Co.

Ely, Addison. October 15, 1902.
Rutherford, N. J., President of Dover, Rockaway and Port Oram Gas Co.

Ely, Addison, Jr. October 15, 1902.
Sussex street, Dover, N. J., General Manager of the Dover, Rockaway and Port Oram Gas Co.

Engel, Francis. October 21, 1903.
Elizabeth, N. J., Superintendent of the Elizabethtown Gas Light Co.

Eustace, John H. October 15, 1902.
Adams street and Michigan avenue, Chicago, Ill., Engineer of the People's Gas Light and Coke Co.

Evans, Charles H. October 16, 1889.
523-524 Rialto Building, Chicago, Ill., Consulting and Contracting Engineer.

Eysenbach, Ernest E. October 16, 1901.
N. W. Cor. Sixth and Jackson streets, St. Paul, Minn., Superintendent of Distribution of St. Paul Gas Light Co.

Faben, Charles R., Jr. October 21, 1885.
327 South Erie street, Toledo, Ohio, General Manager of Toledo Gas Light and Coke Co.

Ferguson, B. B. October 15, 1902.
Portsmouth, Va., P. O. Box 39, Superintendent of the Portsmouth Gas Co.

Ferrier, James. October 16, 1895.
1149 Broad street, Columbus, Ga., P. O. Box 316, Superintendent of the Gas Light Co. of Columbus.

Ferris, Herbert H. October 21, 1903.
13th and Clinton streets, Hoboken, N. J., Superintendent of Hoboken Works, Public Service Corporation of New Jersey.

Fitz, Robert F. October 15, 1890.
Boston, Mass., P. O. Box 5119.

Flemming, Dudley D. October 13, 1880.
249 Washington street, Jersey City, N. J., Gas Engineer.

Flick, Warren J. October 21, 1903.
74 South Main street, Bethlehem, Pa., General Manager of the Wyandotte Gas Co.

Floyd, Frederick W. October 18, 1882.
742 East 12th street, New York, N. Y., Engineer of Gas Works Department of the Quintard Iron Works.

Fodell, William P. October 15, 1879.
50 Laurel street, Philadelphia, Pa., Secretary and Treasurer of Northern Liberties Gas Co.

Fogg, Oscar H. October 15, 1902.
Ocean City, N. J.

Forbes, Charles. October 16, 1901.
London, Ontario, Canada, Superintendent of City Gas Co.

Forbes, James. October 16, 1889.
619 Cherry street, Chattanooga, Tenn., Superintendent of Chattanooga Gas Light Co.

Forstall, Alfred E. October 17, 1888.
Montclair, N. J., Office address, 58 William street, New York, N. Y., Secretary of the Trustees Gas Educational Fund. Consulting Gas Engineer.

Forstall, Walton. October 16, 1895.
Broad and Arch streets, Philadelphia, Pa., P. O. Box 1564, Assistant Engineer of Distribution, Philadelphia Gas Works, The United Gas Improvement Co.

Foss, Eugene N. October 19, 1892.
8 Everett street, Jamaica Plain, Mass., President of Jamaica Plain Gas Light Co.

Fowler, John. October 15, 1879.
39 Laurel street, Philadelphia, Pa., Deily & Fowler, Laurel Iron Works.

Fowler, Samuel J. October 21, 1891.
Thompson Square, Charlestown, Mass., Treasurer and Agent of the Charlestown Gas and Electric Co., Boston, Mass.

Fox, Clifford S. October 21, 1903.
Long Island City, N. Y., Superintendent of Distribution of The East River Gas Co.

Frost, William H. October 15, 1879.
1998 River street, Delray, Mich., P. O. Drawer C, General Manager of Detroit Gas Light and Coke Co.

Frueauff, Frank W. October 17, 1900.
405 17th street, Denver, Col., Secretary and Treasurer Denver Gas and Electric Co.

Ganser, Herbert H. October 16, 1901.
Norristown, Pa., Superintendent of Gas Co. of Montgomery County.

Gartley, Alonzo. October 19, 1898.
223-225 King street, Honolulu, T. H., P. O. Box 144, General Manager of Hawaiian Electric Co., Ltd.

Gartley, William H. October 21, 1885.
1401 Arch street, Philadelphia, Pa., Engineer of Works for Philadelphia, The United Gas Improvement Co.

Gates, Frederick W. May 13, 1874.
17 Herkimer street, Hamilton, Ontario, Canada, President of Hamilton Gas Light Co.

Geggie, David H. October 19, 1881.
2 Place d'Orleans, Quebec, Canada, P. O. Box 207, Secretary and Manager of the Quebec Gas Co.

Geist, C. H. October 21, 1903.
619 New York Life Building, Chicago, Ill., President Hammond Illuminating Co.

George, Thos. L. October 18, 1899.
N. W. corner Broad and Arch streets, Philadelphia, Pa., General Agent of the Philadelphia Gas Works, The United Gas Improvement Co.

Gerould, Charles L. October 17, 1883.
Galesburg, Ill., Manager of Galesburg Gas and Electric Light Co.

Gibbons, P. H. October 18, 1893.
2017 Morris street, Philadelphia, Pa., Superintendent of Mains, Torresdale Filter-Beds, Geo. F. Uber & Co.

Gibbs, W. W. October 20, 1886.
850 Drexel Building, Philadelphia, Pa., Chairman of Managing Committee, The United Gas Improvement Co.

Giblin, John A. October 21, 1891.
10 East Main street, Ilion, N. Y., P. O. Box 513.

Gifford, Nathaniel W. October 21, 1891.
East Boston, Mass., General Manager of East Boston Gas Co.

Gilkyson, J. R. October 21, 1903.
418 Federal street, Camden, N. J., General Agent of the Public Service Corporation of New Jersey.

Gimper, John. October 15, 1890.
Galveston, Texas, Superintendent of Galveston Gas Co.

Glasgow, Arthur G. October 19, 1887.
38 Victoria street, London, S. W., England, Humphreys & Glasgow, London and New York.

Glass, Sheldon J. October 20, 1897.
40 Wall street, New York, N. Y., Secretary and Treasurer of American Light and Traction Co.

Golden, John W. October 18, 1899.
9 Congress street W., Savannah, Ga., P. O. Box 426, Secretary of the Mutual Gas Light Co.

Goodnow, George F. October 16, 1901.
Waukegan, Ill., General Manager of the North Shore Gas Co.

Gould, John A. October 16, 1901.
Room 1031, 100 Boylston street, Boston, Mass., Chief Engineer of the Brookline and Dorchester Gas Light Companies.

Gould, Vernon K. October 21, 1903.
18 Central street, Bangor, Maine, Superintendent of the Bangor Gas Light Co.

Gowen, Samuel C. October 15, 1902.
New Brunswick, N. J., Superintendent of the Gas Light Co. of the City of New Brunswick.

Grace, J. W. October 15, 1902.
13th street and Willow avenue, Hoboken, N. J., District Superintendent of Mains and Services, Public Service Corporation of New Jersey.

Graeff, Harold W. October 15, 1902.
1824 Tioga street, Philadelphia, Pa., Superintendent of Frankford District, Philadelphia Gas Works, The United Gas Improvement Co.

Graf, Carl H. October 19, 1892.
402 Union Trust Building, Detroit, Mich., General Superintendent of J. T. Lynn Co.

Graham, Malcolm Montrose. October 18, 1899.
340 Third avenue, New York, N. Y., Secretary and Treasurer of the New Amsterdam Gas Co.

Graves, Henry C. October 17, 1883.
S. W. corner Main and 2d streets, Dayton, Ohio, Vice-President of Dayton Gas Light and Coke Co.

Green, James. October 21, 1885.
Manchester and Sulphur avenues, St. Louis, Mo., President of Sedalia Gas and Fuel Co., and Moberly Gas and Electric Co.

Greenough, Malcolm S. October 16, 1878.
356 Superior street, Cleveland, Ohio, President Cleveland Gas Light and Coke Co.

Gribbel, John. October 17, 1883.
1513 Race street, Philadelphia, Pa., of John J. Griffin & Co., Meter Manufacturers.

Grover, T. F. October 21, 1903.
Fond du Lac, Wis., Vice-President and General Manager of the Eastern Wisconsin Railway and Light Co.

Guffey, Joseph F. October 15, 1902.
435 Sixth avenue, Pittsburg, Pa., General Manager of the Philadelphia Co.

Guldlin, Olaf N. October 21, 1891.
535 West Berry street, Fort Wayne, Ind., President and Engineer of Western Gas Construction Co.

Gwynn, J. W. October 15, 1890.
Bucyrus, Ohio, P. O. Box 65, Manager of the Bucyrus Gas and Electric Light Co.

Haase, Ewald. October 15, 1902.
182 Wisconsin street, Milwaukee, Wis., P. O. Box 65, Secretary and Treasurer of Milwaukee Gas Light Co.

Hadden, James M. October 19, 1898.
Poughkeepsie, N. Y., Manager Poughkeepsie Gas Works.

Haines, Jansen. October 18, 1899.
417 Locust street, Des Moines, Iowa, Manager of Capital City Gas Light Co.

Hall, Arthur H. October 19, 1898.
350 Alexander avenue, New York, N. Y., Superintendent of Distribution, Central Union Gas Co.

Hambleton, Francis H. October 17, 1888.
5 West Baltimore street, Baltimore, Md., P. O. Box 288, Consulting Engineer of Consolidated Gas Co.

Hamilton, Douglass. October 18, 1899.
1815 Webster avenue, New York, N. Y., Secretary and Treasurer of the Northern Union Gas Co.

Hammatt, Clarence S. October 15, 1890.
1027 Main street, Jacksonville, Fla., President of the Hammatt Contracting Co.

Hantzmon, Harry M. October 15, 1902.
225 N. Royal street, Alexandria, Va., Superintendent of the City Gas Works.

Harbison, John P. May 13, 1874.
700 Main street, Hartford, Conn., President, Treasurer and General Manager Hartford City Gas Light Co.

Hardick, Charles F. October 15, 1902.
5961 Ridge avenue, Philadelphia, Pa., Superintendent of Manayunk District, Philadelphia Gas Works, The United Gas Improvement Co.

Harper, George H. October 16, 1889.
2526 Broad avenue, Altoona, Pa., Manager Altoona Gas Co.

Harris, J. A. October 20, 1886.
1513 Race street, Philadelphia, Pa., with J. J. Griffin & Co., Gas Meter Manufacturers.

Hartpence, C. C. October 18, 1899.
126 Liberty street, New York, N. Y., Gas and Electrical Engineer.

Hatstat, John W. October 27, 1896.
Hartford, Conn., Superintendent of Hartford City Gas Light Co.

Hauk, Charles D. October 21, 1885.
Address unknown.

Hays, John. October 15, 1902.
Carlisle, Pa., President of the Carlisle Gas and Water Co.

Hayward, Thomas J. October 15, 1884.
McHenry and Scott streets, Baltimore, Md., President of the Spanish-American Light and Power Co., Consolidated, Havana, Cuba.

Healy, William M. October 21, 1903.
Fort Dodge, Iowa, General Manager of the Fort Dodge Light and Power Co.

Helme, William E. October 20, 1886.
1339 Cherry street, Philadelphia, Pa., Helme & McIlhenny, Meter Manufacturers.

Herron, J. T. October 15, 1890.
186 Main street, Buffalo, N. Y., Engineer of the Buffalo Gas Co.

Hersh, Grier. October 17, 1900.
York National Bank, York, Pa., President York Gas Co.

Hickenlooper, Andrew. May 13, 1874.
838 Dayton street, Cincinnati, Ohio, formerly President of the Cincinnati Gas and Electric Co.

Hicks, Richard S. October 17, 1894.
73 Warren street, New York, N. Y.

Highlands, S. M. October 17, 1900.
Clinton, Iowa, President and General Manager Clinton Gas Light and Coke Co.

Hill, Samuel. October 21, 1903.
214 Cherry street, Seattle, Wash., President of the Seattle Gas and Electric Co.

Hill, William H. October 19, 1892.
40 Water street, Boston, Mass., P. O. Box 5282, President of Citizens' Gas Light Co., Quincy, Mass.

Hilleke, August F. October 16, 1901.
Ensley, Ala., Assistant Superintendent Semet-Solvay Co.

Hiramatsu, Suyekichi. October 17, 1900.
Nishikicho, Tokio, Japan, Chief Engineer Tokio Gas Co.

Hofman, G. Max. October 19, 1898.
Fort Wayne, Ind., General Superintendent Fort Wayne Gas Co.

Holden, Thomas F. October 20, 1897.
12th and M streets, S. E., Washington, D. C., Superintendent East Station Works, Washington Gas Light Co.

Holmes, Rufus E. October 18, 1899.
Winsted, Conn., P. O. Station A., President of the Winsted Gas Co.

Holzer, Edwin G. October 17, 1894.
North Front street, Easton, Pa., Superintendent of the Delaware Gas Light Co., the Easton Gas Co., the Easton Fuel Gas Co., Easton, Pa., and the People's Light, Heat and Power Co., Phillipsburg, N. J.

Hopper, William H. October 18, 1882.
137 West Washington lane, Germantown, Philadelphia, Pa., Director in Wausau (Wis.) Gas Light and Coke Co., Beloit (Wis.) Gas Light and Coke Co., and Gainesville (Texas) Light and Fuel Co.

Horton, Thomas O. October 18, 1899.
264 Bay street, Stapleton, S. I., N. Y., Secretary and Manager New York and Richmond Gas Co., Borough of Richmond, City of New York.

Hough, David Leavitt. October 19, 1892.
13-21 Park Row, New York, N. Y., President of the United Engineering and Contracting Co.

Howard, Charles A. October 15, 1902.
Aberdeen, So. Dak., P. O. Box 867, President of the Aberdeen Gas Co.

Howes, R. V. October 18, 1899.
Winston-Salem, N. C., P. O. Box 367, Superintendent of the Winston-Salem Gas and Lighting Co.

Hoyt, Wm. Greeley. October 15, 1902.
801 Third avenue, New York, N. Y., Vice-President and Secretary of the Standard Gas Light Co.

Humphreys, Alexander C. October 20, 1875.
31 Nassau street, New York, N. Y., M. E., M. Inst. C. E., etc., of Humphreys & Glasgow, President of Gas Companies, Buffalo, N. Y., and President of Stevens Institute of Technology.

Humphreys, C. J. R. October 19, 1881.
31 Nassau street, New York, N. Y., of Humphreys & Glasgow.

Humphreys, James J., Jr. October 19, 1898.
West 5th street and Sheepshead Bay road, Coney Island, Brooklyn, N. Y., Manager of Brooklyn Borough Gas Co.

Huntress, Fred A. October 15, 1902.
Halifax, N. S., Manager of the Halifax Electric Tramway Co., Ltd.

Hurlburt, A. October 21, 1903.
Broad and Arch streets, Philadelphia, Pa., Engineer with The United Gas Improvement Co.

Hyde, Henry H. October 15, 1902.
305 Sixth street, Racine, Wis., P. O. Box 295, Secretary and Manager of the Racine Gas Light Co.

Irwin, C. Henry. October 21, 1903.
196 Union avenue, Long Branch, N. J., Treasurer of the Consolidated Gas Co., of New Jersey.

Isbell, Charles W. May 12, 1875.
245 Broadway, New York, N. Y., President of Isbell-Porter Co., Gas Engineers and Contractors.

Jackson, Walter M. October 19, 1887.
(9 Oliver street, Stamford, Conn.) New York, N. Y., P. O. Box 808.

Jelliffe, C. N. October 21, 1903.
40 Wall street, New York City, Auditor of the American Light and Traction Co.

Johnston, Mervyn E. October 15, 1902.
776 Broad street, Newark, N. J., General Auditor of the Gas Department, Public Service Corporation of New Jersey.

Jones, Edward C. October 15, 1879.
630 Rialto Building, San Francisco, Cal., Gas Engineer of California Gas and Electric Corporation.

Jones, T. C. October 19, 1898.
6 W. Winter street, Delaware, Ohio, Secretary Delaware Gas Co.

Jourdan, Edward R. October 17, 1900.
4 Irving place, New York, N. Y., Assistant General Superintendent of Mains, Consolidated Gas Co.

Jourdan, James H. October 21, 1891.
Nevins and Degraw streets, Brooklyn, N. Y., Chief Engineer of Western Division Brooklyn Union Gas Co.

Kellogg, L. L. October 15, 1890.
528 Fifth street, Sioux City, Iowa, Vice-President and Manager of Sioux City Gas and Electric Co.

Kempf, John, Jr. October 19, 1898.
769 Main street, Salt Lake City, Utah, P. O. Box 52, Superintendent Gas Department, Utah Light and Power Co.

Kennedy, James S. October 17, 1900.
Foot of East 115th street, New York, N. Y., Superintendent Standard Gas Light Company's Works.

Keppelman, John H. October 21, 1891.
144 North 4th street, Reading, Pa., P. O. Box 384, Superintendent of the Consumers' Gas Co.

Kidner, R. W. October 21, 1903.
London, Ont., Canada, Secretary of the City Gas Company of London, Ont.

Kingsbury, Frank D. May 13, 1874.
8 East Market street, Corning, N. Y., P. O. Drawer 884, President of Corning Fuel and Heating Co.

Klumpp, John B. October 18, 1899.
N. W. corner Broad and Arch streets, Philadelphia, Pa., Assistant Inspecting Engineer of The United Gas Improvement Co.

Knapp, Isaac N. October 19, 1898.
Ardmore, Pa., P. O. Box 496, Gas Engineer.

Knight, Chas. S. October 15, 1890.
Fort Wayne, Ind.

Knight, J. J. October 16, 1901.
123 South West street, Kalamazoo, Mich., Vice-President of the Kalamazoo Gas Co.

Knowles, W. P. October 27, 1896.
23 E. Canal street, Richmond, Va., Superintendent and Engineer of City Gas Works.

Konrad, Augustus. October 18, 1899.
40 North Washington street, Tarrytown, N. Y., P. O. Box 383.

Kuehn, Jacob L. October 19, 1881.
33 E. Philadelphia street, York, Pa., P. O. Box 344, Superintendent and Engineer of York Gas Co.

Lamson, Charles D. October 19, 1881.
240 Main street, Worcester, Mass., President and General Manager of Worcester Gas Light Co.

Lane, F. K. October 15, 1902.
White Plains, N. Y., Superintendent of the White Plains Lighting Co.

Lane, James W. October 21, 1891.
1046 West 4th street, Williamsport, Pa., Superintendent and Engineer of Williamsport Gas Co.

Lathrop, A. P. October 18, 1899.
N. W. corner 6th and Jackson streets, St. Paul, Minn., President and General Manager St. Paul Gas Light Co.

Lawrence, W. F. October 19, 1898.
Long Island City, N. Y., Superintendent of New Amsterdam Gas Co., Ravenswood Works.

Learned, Charles A. October 27, 1896.
40 Colony street, Meriden, Conn., P. O. Box 575, Superintendent and Manager of Meriden Gas Light Co.

Learned, Everett C. October 19, 1881.
118 Maple street, New Britain, Conn., P. O. Box 355, Superintendent of New Britain Gas Light Co.

Learned, Waldo A. October 18, 1882.
2 Jewett street, Newton, Mass., General Superintendent of Newton and Watertown Gas Light Co.

Leetch, John. October 17, 1894.
1409 31st street, Washington, D. C., General Manager of Washington Gas Light Co.

Leland, George B. October 21, 1903.
Norwich, Conn., Superintendent of the Norwich Gas and Electric Co.

Leonard, Charles F. October 18, 1899.
14 Bedford street, Fall River, Mass., P. O. Box 66, Superintendent of Works of the Fall River Gas Works Co.

Light, George. October 16, 1901.
205 East 1st street, Dayton, Ohio, Assistant Superintendent of the Dayton Gas Light and Coke Co.

Light, Joseph. October 21, 1885.
203 East 1st street, Dayton, Ohio, Engineer and Superintendent of Dayton Gas Light and Coke Co.

Lillie, Lewis. October 21, 1891.
N. W. corner Broad and Arch streets, Philadelphia, Pa., Secretary and Treasurer of The United Gas Improvement Co.

Lindstedt, Julius. October 15, 1902.
1111 South 8th street, Manitowoc, Wis., Secretary and Manager of the Manitowoc Gas Light Co.

Linton, S. E., Jr. October 16, 1901.
Savannah, Ga., P. O. Box 426, Superintendent of the Mutual Gas Light Co.

Little, F. W. October 20, 1897.
125 North Jefferson avenue, Peoria, Ill., Vice-President Peoria Gas and Electric Co.

Littlehales, Thomas. May 13, 1874.
715 East Genesee street, Syracuse, N. Y., Consulting Gas Engineer.

Littlehales, Thomas G. October 19, 1898.
Chester, Pa., P. O. Box 25, Superintendent of the Semet-Solvay Co.

Lloyd, Ernest F. October 15, 1902.
860 Greenwood avenue, Detroit, Mich., President and Treasurer of the Adrian (Mich.) Gas Co.

Logan, John D. October 18, 1893.
Brooklyn, E. D., N. Y., P. O. Box 6, Station G, Vice-President of Greenpoint Gas Light Co.

Logan, William J. October 19, 1892.
Brooklyn, E. D., N. Y., P. O. Box 6, Station G, Proprietor of Logan Iron Works.

Lomax, Clarence S. October 15, 1902.
25 Pleasant street, Everett, Mass., Chemist of the Massachusetts Pipe Line Gas Co. and New England Gas and Coke Co.

Loomis, Burdett. October 15, 1884.
52 William street, New York, N. Y., Engineer of Loomis-Pettibone Gas Machinery Co.

Lowe, Thaddeus S. C. October 20, 1886.
Pasadena, Cal.

Ludlam, Edwin. October 15, 1873.
180 Remsen street, Brooklyn, N. Y., Secretary of Brooklyn Union Gas Co.

Lynch, Eugene T. October 16, 1895.
Rhinebeck, N. Y.

Lynn, James T. October 17, 1883.
402 Union Trust Building, Port Huron, Mich., President of the Port Huron Gas Co.

M'Caffrey, George F. October 15, 1902.
1 Putnam Court, Cambridgeport, Mass.

McCleary, Alexander J. October 17, 1888.
22d and Filbert streets, Philadelphia, Pa., Superintendent Street Lighting Department of the Equitable Illuminating Gas Light Co.

McCullough, Edmund H. October 18, 1882.
224 South 3d street, Philadelphia, Pa., President of Westmoreland Coal Co.

Macdonald, Benjamin J. October 15, 1890.
296 Grand street, Newburgh, N. Y.

McDonald, Donald. October 15, 1902.
Louisville, Ky., President of the Kentucky Heating Co.

McDonald, William. October 15, 1879.
51 Lancaster street, Albany, N. Y., General Superintendent of American Meter Co.

McGregor, Wm. October 15, 1902.
308 High street, Pawtucket, R. I., P. O. Box 593, Secretary and Superintendent of the Pawtucket Gas Co.

McIlhenny, James S. October 15, 1890.
26th and G streets, N. W., Washington, D. C., Superintendent of Washington Gas Light Co.

McIlhenny, John. May 12, 1875.
1339 Cherry street, Philadelphia, Pa., Helme & McIlhenny, Meter Manufacturers.

McIlhenny, John D. October 16, 1895.
1339 Cherry street, Philadelphia, Pa., President of Gas Co. of Montgomery County, Norristown, Pa.

McKay, William E. October 19, 1892.
Dudley Road, Milton, Mass., Engineer of Boston Gas Light Co. and Bay State Gas Co., Boston, Mass.

McKenzie, W. H. October 17, 1900.
Sioux Falls, South Dakota, Superintendent Sioux Falls Gas Light Co.

McLean, George. October 19, 1898.
669 Main street, Dubuque, Iowa, P. O. Drawer 438, President Key City Gas Co.

McLean, John R. October 17, 1894.
413 10th street, N. W., Washington, D. C., President of Washington Gas Light Co.

MacMillan, George. October 21, 1891.
214 South 7th street, La Crosse, Wis., Vice-President, Treasurer and General Manager of La Crosse Gas and Electric Co.

Macmillan, Robert. October 15, 1902.
931 Walnut street, Kansas City, Mo., Secretary of the Kansas City Missouri Gas Co.

McMillin, Emerson. May 13, 1874.
40 Wall street, New York, N. Y., President of Columbus Gas Light and Coke Co., Laclede Gas Co., Milwaukee Gas Co., Grand Rapids Gas Co. and Consolidated Gas Co. of New Jersey, etc.

Macmun, G. F. October 16, 1901.
Marlboro, Mass., General Manager of the Marlboro Gas Light Co.

Maloney, Andrew P. October 21, 1903.
1504 Tioga street, Philadelphia, Pa., Secretary and Treasurer of the Lakewood Gas Co.

Manier, Robert W. October 18, 1899.
40 Chenango street, Binghamton, N. Y., Treasurer of the Binghamton Gas Works.

Mann, Howard E. October 17, 1900.
Foot of Willson avenue, Cleveland, Ohio, Superintendent of Works No. 2, Cleveland Gas Light and Coke Co.

*Mansur, John H. October 17, 1894. October 16, 1901.
436 Walnut street, Royersford, Pa., P. O. Box 104, President of the Consolidated Schuylkill Gas Co., Phoenixville, Pa., and the Keystone Meter Co.

Marani, Virgil G. October 20, 1897.
356 Superior street, Cleveland, Ohio, Assistant Engineer and Civil Engineer, Cleveland Gas Light and Coke Co.

Marks, William D., Ph.B., C. E. October 17, 1900.
216 Bourse, Philadelphia, Pa., President Consolidated Railway and Lighting Co., Director City Heat and Light Co., and Vice-President Durham Light and Power Co. of Durham, N. C.

Marple, William M. October 21, 1903.
423 Jefferson avenue, Scranton, Pa., Engineer Scranton Gas and Water Co.

Marshall, W. H. October 15, 1902.
1401 Arch street, Philadelphia, Pa., Assistant Secretary of The United Gas Improvement Co.

Max, William J. October 20, 1897.
17 Mulberry street, Middletown, N. Y., Superintendent Orange County Gas and Electric Co.

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* First date is that of election to membership in the Association; second that of transfer from Associate to Active membership.

Mayer, Frederick J. October 15, 1884.
Scott and McHenry streets, Baltimore, Md., Engineer with Bartlett, Hayward & Co.

Mayers, J. Alex. October 19, 1898.
44 Broad street, New York, N. Y., Gas Engineer.

Maynard, H. B. October 17, 1900.
Ottumwa, Iowa, Manager and Treasurer Ottumwa Gas Light, Heat and Power Co.

Meginniss, Edward B. October 15, 1902.
2102 No. Charles street, Baltimore, Md., Assistant Auditor and Manager of Fuel Department of the Consolidated Gas Co. of Baltimore.

Meginniss, Nathaniel T. October 15, 1902.
851 Equitable Building, Baltimore, Md.

Merrifield, L. L. October 19, 1898.
157 Dowling avenue, Toronto, Canada, Gas Engineer Canadian Gas Association.

Merritt, Albert H. October 15, 1902.
615 Ferry avenue, Niagara Falls, N. Y., Superintendent of the Niagara Falls Gas and Electric Light Co.

Merritt, A. H. October 15, 1902.
Vineland, N. J., Superintendent of the Vineland Light and Power Co.

Merritt, Charles H. October 15, 1879.
350 Main street, Danbury, Conn., President of Danbury and Bethel Gas and Electric Light Co.

Merritt, William H. October 21, 1903.
Lebanon, Pa., Superintendent of the Lebanon Gas Co.

Middleton, Robert L. October 17, 1894.
1411 30th street, N. W., Washington, D. C., Superintendent of Georgetown Gas Light Co.

Miller, Alten S. October 16, 1889.
5 West Baltimore street, Baltimore, Md., Manager of Consolidated Gas Co.

Miller, Carroll. October 18, 1899.
155 Michigan avenue, Chicago, Ill., Consulting Engineer.

Miller, C. O. G. October 21, 1891.
455 Sutter street, San Francisco, Cal., President of Pacific Gas Improvement Co.

Miller, Ira Abbot. October 17, 1900.
111 E. Kiowa street, Colorado Springs, Col., Secretary Colorado Springs Light and Power Co.

Miller, Thomas David. October 21, 1903.
Baronne and Common streets, New Orleans, La., Manager of the New Orleans Lighting Co.

Miller, William A. October 27, 1896.
S. W. corner 4th and Plum streets, Cincinnati, Ohio, Superintendent of Gas Department, Cincinnati Gas and Electric Co.

Miller, William B. October 21, 1903.
Augusta, Ga., Superintendent of the Gas Light Co. of Augusta.

Milsted, William N. October 19, 1887.
11th avenue and 47th street, New York, N. Y., Secretary of American Meter Co.

Mitchell, Kerr M. October 16, 1889.
8th and Francis streets, St. Joseph, Mo., General Manager of St. Joseph Gas Co.

Molony, Martin. October 18, 1899.
37th and Market streets, Philadelphia, Pa., Superintendent West Philadelphia District, Philadelphia Gas Works, The United Gas Improvement Co.

Moore, A. W. October 21, 1903.
Woodstock, Ontario, Canada, Secretary of the Woodstock Gas Light Co.

Moore, Northrop. October 19, 1898.
Kansas City, Kansas, Superintendent Wyandotte Gas Co.

Morehead, J. M. October 15, 1902.
157 Michigan avenue, Chicago, Ill., Consulting Engineer with the People's Gas Light and Coke Co.

Morgans, William H. October 19, 1887.
11 South Saginaw street, Pontiac, Mich., Manager and Treasurer of Pontiac Gas and Electric Co.

Morrell, Edward E. October 20, 1897.
221 Wesley avenue, Oak Park, Ill., Gas Engineer.

Morris, Henry G. October 15, 1879.
408 Philadelphia Bourse, Philadelphia, Pa., Engineer and Machinist.

Morris, W. Cullen. October 18, 1899.
Ravenswood, Long Island City, N. Y., Engineer of the Ravenswood Works of the New Amsterdam Gas Co.

Morrison, H. K. October 19, 1898.
5 Capitol street, Concord, N. H., Superintendent Concord Light and Power Co.

Morse, C. W. October 15, 1902.
Corey Building, Marlboro, Mass., General Manager Marlboro Gas Co., the Amesbury Gas Co., and Quincy Gas Co.

Morton, Frederick N. October 16, 1895.
Broad and Arch streets, Philadelphia, Pa.

Moses, Frank D. October 17, 1894.
147 East State street, Trenton, N. J., Gas Engineer and Contractor.

Moses, George W. October 13, 1880.
Chelsea, Mass., P. O. Box 28, Treasurer and General Manager of Chelsea Gas Light Co.

Motley, George S. October 16, 1901.
Lowell, Mass., President and General Manager of the Lowell Gas Light Co.

Moulton, Wm. Henry. October 15, 1902.
9 Temple street, Portland, Me., Vice President of the Portland Gas Light Co.

Nettleton, Charles H. October 20, 1875.
Derby, Conn., P. O. Drawer L, President of Derby Gas Co., and of New Haven Gas Light Co.

Norcross, J. Arnold. October 27, 1896.
80 Crown street, New Haven, Conn., Engineer of New Haven Gas Light Co.

Norcross, J. C. October 18, 1899.
Harrison, N. J., care General Electric Co.

Norland, Manning A. October 21, 1903.
157 Michigan avenue, Chicago, Ill., Assistant Engineer of the People's Gas Light and Coke Co.

Norris, Rollin. October 16, 1889.
1401 Arch street, Philadelphia, Pa., P. O. Box 1564, Superintendent of Works of The United Gas Improvement Co.

Norton, Walter F. October 19, 1898.
9 Courtland street, Nashau, N. H., P. O. Box 275, Superintendent Nashua Light, Heat and Power Co.

Nute, Joseph E. October 17, 1888.
14 Bedford street, Fall River, Mass., P. O. Box 66, Manager of Fall River Gas Works Co.

Nutting, Charles H. October 18, 1899.
37 Gaylord street, Chicopee, Mass., P. O. Box 1221, Superintendent of Chicopee Gas Light Co.

Oill, George L. October 21, 1903.
St. Thomas, Ontario, Canada, Manager of the St. Thomas Gas Co.

Old, George. October 16, 1901.
210 St. George street, St. Augustine, Fla., P. O. Box 747, Superintendent of the St. Augustine Gas and Electric Light Co.

Page, Carter H., Jr. October 18, 1893.
N. W. corner Broad and Arch streets, Philadelphia, Pa., P. O. Box 1564, Commercial Agent of The United Gas Improvement Co.

Palmer, L. T. October 21, 1903.
Tonawanda, N. Y., Secretary and General Manager of the Niagara Light, Heat and Power Co.

Parker, Frank H. October 15, 1902.
102 So. Winooski avenue, Burlington, Vt., Superintendent of the Burlington Light and Power Co.

Parker, Richard Marsh. October 19, 1898.
186 Main street, Buffalo, N. Y., Assistant Secretary Buffalo Gas Co.

Parker, T. R. October 19, 1898.
105 Division street, Napa, Cal.

Patterson, H. V. October 21, 1903.
6th and Provost streets, Jersey City, N. J., Superintendent of Mains and Services, Jersey City District, Hudson County Division, Public Service Corporation of New Jersey.

Paullins, William C. October 18, 1899.
Pueblo, Col., Superintendent of Pueblo Gas and Fuel Co.

Pearson, William H. October 20, 1875.
19 Toronto street, Toronto, Ont., Canada, General Manager and Secretary of Consumers' Gas Co.

Pearson, William H., Jr. October 17, 1888.
95 Isabella street, Toronto, Ont., Canada, Engineer and Superintendent of Consumers' Gas Co.

Pease, A. C. October 21, 1903.
119 Woodworth avenue, Yonkers, N. Y., Superintendent of Yonkers District, Westchester Lighting Co.

Pelton, Frank Kerr. October 18, 1899.
402 Union Trust Building, Detroit, Mich., Secretary and Treasurer of the Bowling Green Gas Co., Bowling Green, Ohio.

Perkins, James D. October 18, 1882.
228 Produce Exchange Building, New York, N. Y., President of the Perkins Co.

Perry, Joseph A. October 15, 1902.
Broad and Arch streets, Philadelphia, Pa., Engineer with The United Gas Improvement Co.

Pettes, Wm. H. October 15, 1902.
575 Broad street, Newark, N. J., General Agent of the Essex and Hudson Division of Public Service Corporation of New Jersey.

Pinkney, Edward A. October 21, 1891.
Middletown, Pa., General Manager of Steelton Home Gas Co., and Secretary and Treasurer of Middletown Gas Light Co.

Planck, J. W. October 18, 1899.
3 First street, Ilion, N. Y., P. O. Box 414, Superintendent Gas Department, Herkimer Light and Power Co.

Polk, Roger W. October 15, 1902.
Berwick House, Rutland, Vt., Superintendent of the People's Gas Light Co.

Pollitt, L. I. October 16, 1901.
Pine Bluff, Ark., Manager of the Pine Bluff Light and Water Co.

Pond, E. C. October 15, 1902.
135 Sycamore street, Petersburg, Va., Manager of the Petersburg Gas Co.

Poor, Frank B. October 27, 1896.
Address unknown.

Porter, Joseph F. October 27, 1896.
205 Market street, Alton, Ill., President and Treasurer of Alton Railway, Gas and Electric Co.

Powell, H. H. October 21, 1903.
Woodstock, Ontario, Canada, President of the Woodstock Gas Light Co.

Powers, Edgar T. October 16, 1901.
5 and 7 W. Baltimore street, Baltimore, Md., Secretary of Consolidated Gas Co.

Pratt, Edward G. October 20, 1886.
182 Wisconsin street, Milwaukee, Wis., Vice-President and General Manager of Milwaukee Gas Light Co.

Prichard, Charles F. October 17, 1883.
90 Exchange street, Lynn, Mass., General Manager of Lynn Gas and Electric Co.

Printz, Eugene. May 13, 1874.
North 6th street, Zanesville, Ohio, Superintendent of Zanesville Gas Light Co.

Purcell, T. V. October 17, 1900.
Ashland Block, Chicago, Ill., General Manager of the Ogden Gas Co.

Putnam, W. R. October 21, 1903.
Red Wing, Minn., Secretary and Manager of the Red Wing Gas and Electric Co.

Quackenbush, Charles H. October 15, 1902.
Ardmore, Pa., Superintendent of the Gas Department, Merion and Radnor Gas and Electric Co.

Quinn, Andrew K. October 19, 1887.
181 Thames street, Newport, R. I., P. O. Box 305, Treasurer of Newport Gas Light Co.

Ramsdell, George G. October 15, 1879.
395 Broadway, New York, N. Y., General Manager of the Connelly Iron Sponge and Governor Co.

Ramsey, Wm. Heines Crawford. October 15, 1902.
420 Main street, Johnstown, Pa., Superintendent of the Consumers' Gas Co.

Randolph, William W. October 17, 1894.
31 Nassau street, New York, N. Y., Engineer Humphreys & Glasgow.

Reaves, Robert. October 15, 1902.
3 Platt place, Scranton, Pa., P. O. Box 454, Superintendent of the Scranton Gas and Water Co.

Reichelt, A. F. October 20, 1897.
43 Cedar street, New York, N. Y., care of Audit Co. of New York City.

Reilly, John W. October 21, 1891.
116 South 6th street, Wilmington, N. C., care of Consolidated Railway, Lighting and Power Co.

Reitemeyer, A. F. October 15, 1902.
1088 Elizabeth avenue, Elizabeth, N. J., Superintendent, Secretary and Treasurer of the Perth Amboy Gas Light Co.

Rice, Henry L. October 17, 1894.
Norfolk, Va., General Manager City Gas Co. of Norfolk.

Richardson, Frank S. October 19, 1881.
84 Main street, North Adams, Mass., Vice-President, Treasurer and Manager of North Adams Gas Light Co.

Ringwood, Thomas. October 15, 1890.
4 Armory street, Ilion, Herkimer County, N. Y.

Riselay, William S. October 18, 1899.
188 Main street, Buffalo, N. Y., Secretary and Treasurer of Buffalo Gas Companies, and People's Gas Light Co. of Buffalo.

Roberts, George J. October 17, 1894.
Broad and Arch streets, Philadelphia, Pa., Engineer of The United Gas Improvement Co.

Robison, Chas. D. October 17, 1900.
122 Genesee street, Auburn, N. Y., Superintendent and Treasurer Auburn Gas Co., and Superintendent Seneca Falls and Waterloo Gas Light Co.

Rogers, W. H. October 17, 1894.
188 and 190 Ellison street, Paterson, N. J., P. O. Box 1914, General Agent, Gas and Electric Department, Public Service Corporation of New Jersey.

Roohan, P. F. October 15, 1902.
491 Broadway, Saratoga Springs, N. Y., Superintendent of the Saratoga Gas, Electric Light and Power Co.

*Roper, George D. October 27, 1896. October 16, 1901.
Rockford, Ill., Vice-President of the Boone (Ia.) Gas Co.

Rosenquest, Eugene H. October 18, 1899.
Main street, Westchester, Bronx Borough, New York City, N. Y., President and General Manager of the Bronx Gas and Electric Co.

Rosenthal, Albert. October 19, 1898.
123 South 8th avenue, Mount Vernon, N. Y., Superintendent Mount Vernon District of the Westchester Lighting Co.

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* First date is that of election to membership in the Association ; second that of transfer from Associate to Active membership.

Ross, Alexander. October 27, 1896.
716 Locust street, St. Louis, Mo., Secretary of Laclede Gas Light Co.

Ross, J. Charles. October 19, 1898.
Steubenville, Ohio, General Manager of the Steubenville Traction and Light Co.

Rossman, G. M. October 19, 1898.
18 Roxbury street, Keene, N. H., Treasurer Keene Gas and Electric Co.

Rowland, Charles L. October 17, 1888.
102 Greene street, Brooklyn, N. Y., Proprietor of the Morton Iron Works.

Rowland, Thomas F. May 13, 1874.
329 Madison avenue, New York, N. Y., President of the Continental Iron Works, Brooklyn, N. Y.

Rowland, William L. October 20, 1886.
4800 Chester avenue, Philadelphia, Pa., Superintendent of Ammonia Co. of Philadelphia.

Royce, F. P. October 21, 1903.
159 Devonshire street, Boston, Mass., Vice-President of the Springfield (Mass.) Gas Light Co. and Suburban Gas and Electric Co., Revere.

Rusby, John M. October 17, 1888.
N. W. corner Broad and Arch streets, Philadelphia, Pa., P. O. Box 1564, Inspecting Engineer of The United Gas Improvement Co.

Russell, Daniel R. October 19, 1887.
417 Pine street, St. Louis, Mo., Vice-President of the Parker-Russell Mining and Manufacturing Co.

Russell, Henry Z. October 17, 1894.
Honesdale, Pa., Secretary and Treasurer of Honesdale Gas Co.

Sargent, Fred. H. October 16, 1901.
370 Essex street, Lawrence, Mass., P. O. Box K, Assistant Agent of the Lawrence Gas Co.

Sawyer, F. H. October 15, 1902.
82 Plume street, Norfolk, Va., Secretary and Treasurer of the City Gas Co. of Norfolk.

Schenck, Rudolph. October 21, 1903.
157 Michigan avenue, Chicago, Ill., Assistant Engineer of the People's Gas Light and Coke Co.

Schniewind, F. October 27, 1896.
Ph.D., 17 Battery place, New York, N. Y., General Manager of the United Coke and Gas Co.

Schwarm, C. A. October 17, 1900.
Hornellsville, N. Y., care Hornell Gas Light Co.

Scott, Charles L. October 21, 1903.
Commonwealth Building, Philadelphia, Pa., Secretary of the Pennsylvania Gas Improvement Co.

Scranton, George H. October 21, 1903.
Derby, Conn., Secretary of the Derby Gas Co.

Scranton, Worthington. October 15, 1902.
Scranton, Pa., Assistant to the President of the Scranton Gas and Water Co.

Searle, Robert M. October 15, 1890.
250 South 10th avenue, Mount Vernon, N. Y., P. O. Drawer E, Engineer Gas Department of the Westchester Lighting Co.

Seaverns, F. October 17, 1883.
228 Produce Exchange Building, New York, N. Y., Treasurer of the Perkins Co.

Secord, Warren L. October 16, 1901.
72 Washington avenue, New Rochelle, N. Y., Special Foreman of Distribution for the Westchester Lighting Co.

Serrell, L. W. October 15, 1902.
99 Cedar street, New York, N. Y., President of the Fishkill and Matteawan Gas Co.

Serrill, William J. October 21, 1891.
Broad and Arch streets, Philadelphia, Pa., P. O. Box 1564, Engineer of Distribution, The United Gas Improvement Co.

Seymour, E. B. October 15, 1902.
54 East Market street, Corning, N. Y., Manager and Assistant Treasurer of the Corning Gas and Electric Co.

Seymour, William W. October 16, 1901.
1001 "A" street, Tacoma, Wash., President Tacoma Gas and Electric Light Co.

Shattuck, John D. October 19, 1898.
517 Market street, Chester, Pa., Vice-President and Manager Suburban Gas Co. of Philadelphia.

Shelton, Frederick H. October 17, 1888.
1003 Pennsylvania Building, 15th and Chestnut streets, Philadelphia, Pa., Secretary of various gas companies.

Shepherd, Herbert L. October 21, 1903.
Dover, N. H., Treasurer and General Manager of the United Gas and Electric Co.

Sherman, F. C. October 20, 1875.
80 Crown street, New Haven, Conn., P. O. Drawer 107, Consulting Engineer of the New Haven Gas Light Co.

Sickels, Avery Clinton. October 15, 1902.
Steelton, Pa., President of the Steelton Home Gas Co. and of the Middletown Gas Light Co.

Simpson, Colin C. October 21, 1903.
4 Irving place, New York City, Assistant Secretary and General Superintendent of Mains, Consolidated Gas Co., of New York.

Simpson, Mastin. October 17, 1900.
730 Delaware street, Kansas City, Mo., Cashier of H. P. Wright & Co. (Bonds and Stocks.)

Sisson, Frank N. October 20, 1886.
51 Maiden lane, Albany, N. Y., Salesman.

Slade, Foster Cornell. October 15, 1902.
76 Highland avenue, Yonkers, N. Y., Gas Engineer and Draughtsman of Consolidated Gas Co.

Slade, Richmond E. October 19, 1892.
109 Main street, Lockport, N. Y., Superintendent Lockport Gas and Electric Light Co.

Slaney, Henry C. October 16, 1889.
466 6th street, Brooklyn, N. Y., Engineer of the Equity Works of the Brooklyn Union Gas Co.

Slater, A. B., Jr. October 18, 1888.
Fort Wayne, Ind., Constructing Gas Engineer.

Sloper, Andrew J. October 18, 1899.
25 W. Main street, New Britain, Conn., President of New Britain Gas Light Co.

Smart, Fred. R., Jr. October 17, 1900.
25 West Market street, York, Pa., General Manager York Gas Co.

Smith, John W. October 20, 1886.
60 Laurel street, Philadelphia, Pa., Superintendent of Northern Liberties Gas Co.

Smith, William H. October 21, 1891.
1931 South 9th street, Philadelphia, Pa., City District Superintendent of Distribution, The United Gas Improvement Co.

Snow, William H. October 19, 1887.
Holyoke, Mass., Manager of Gas and Electric Department of City of Holyoke.

Somerville, James. October 20, 1875.
Corner Penn and Louisiana streets, Indianapolis, Ind., Engineer and Superintendent of Indianapolis Gas Co.

Spangenberg, B. H. October 20, 1897.
19th street and Allegheny avenue, Philadelphia, Pa., Superintendent of Meters, The United Gas Improvement Co.

Spaulding, Charles F. October 16, 1878.
Townsend street, Waltham, Mass., Superintendent of Waltham Gas Light Co.

Spinning, W. V. October 18, 1899.
12 West Third street, Peru, Ind., Lock Box 93, Superintendent Peru American Gas Co.

Spragle, L. D. October 19, 1898.
210 West Main street, Johnstown, N. Y., P. O. Box 234, Acting Agent of the Fulton County Gas and Electric Co.

Sprague, Charles H. October 18, 1882.
70 Kilby street, Boston, Mass.

Springer, Edward S. October 15, 1902.
Leavenworth, Kansas, Manager of the Leavenworth Light and Heating Co.

Stacey, James E. October 27, 1896.
239 Mill street, Cincinnati, Ohio, President and Manager of the Stacey Manufacturing Co.

Steck, Henry. October 21, 1891.
631 Chestnut street, Philadelphia, Pa.

Stelling, C. A. October 15, 1902.
Passaic, N. J., Assistant Superintendent of the Paterson and Passaic Gas and Electric Co.

Stephenson, William. October 21, 1903.
South Amboy, N. J., Agent for the Citizens' Light and Fuel Co.

Stilwell, B. W. October 18, 1899.
240 Palisade avenue, Yonkers, N. Y., Secretary and Assistant Treasurer of the Westchester Lighting Co.

Stiness, George A. October 15, 1902.
123 Clay street, Pawtucket, R. I., Assistant Treasurer of the Pawtucket Gas Co.

Stirzel, J. W. October 16, 1895.
1517 Erie avenue, Philadelphia, Pa., Constructing Engineer, Philadelphia Gas Works, The United Gas Improvement Co.

Stockton, Richard. October 15, 1902.
Trenton, N. J., Assistant to the President of the South Jersey Gas, Electric and Traction Co.

Stratton, F. A. October 16, 1901.
Mount Vernon, N. Y., Vice-President of the Westchester Lighting Co.

Strecker, Alexander H. October 20, 1897.
575 Broad street, Newark, N. J., Engineer of the Essex and Hudson Division of Public Service Corporation of New Jersey.

Strong, C. D. October 17, 1900.
Address Unknown.

Stroud, Morris W. October 16, 1895.
222 South Third street, Philadelphia, Pa., President of the American Gas Co.

Summers, George. October 15, 1902.
28 Lincoln avenue, Chicago, Ill., Superintendent of Construction, People's Gas Light Co. of Chicago.

* Summey, D. L. October 19, 1898. October 21, 1903.
Center and Leavenworth streets, Waterbury, Conn., Assistant Superintendent of The United Gas Improvement Co.

Taber, Robert B. October 19, 1881.
Burlington, Vt.

Tait, Frank M. October 17, 1900.
29 Main street, New London, Conn., General Manager of New London Gas and Electric Co.

Talbott, Frank. October 15, 1902.
Danville, Va., Assistant Superintendent, Secretary and Treasurer of the City of Danville, Va., Gas Department.

Taussig, J. Hawley. October 16, 1901.
Newark, N. J., Superintendent of the Market Street Works of the Public Service Corporation of New Jersey.

Tayler, George H. October 18, 1882.
209 Main street, Warren, Ohio, Secretary, Treasurer and Superintendent of Warren Gas Light Co.

Taylor, J. D., Jr. October 16, 1901.
Canon City, Col., Secretary and General Manager of the Canon City Gas Co.

Tenney, Charles H. October 21, 1903.
159 Devonshire street, Boston, Mass., President of the Springfield (Mass.) Gas Light Co., and Suburban Gas and Electric Co., Revere.

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Terry, F. L. October 18, 1899.
New Britain, Conn., P. O. Box 724, Superintendent of the Connecticut Railway and Lighting Co.

Thomas, Charles G. M. October 15, 1902.
150 Franklin place, Flushing, N. Y., Vice-President and General Manager of the Newtown and Flushing Gas Co.

Thomas, John W. October 19, 1898.
Vallejo, Cal., Superintendent Vallejo Gas Light Co.

Thompson, F. De V. October 16, 1901.
123 State street, Springfield, Mass., P. O. Box 1642, General Manager of the Springfield Gas Light Co.

Thompson, Paul. October 17, 1900.
N. W. corner Broad and Arch streets, Philadelphia, Pa., P. O. Box 1564, Assistant General Agent Philadelphia Gas Works, The United Gas Improvement Co.

Thwing, Orrell O. October 16, 1895.
Main and Howard streets, St. Louis, Mo., Superintendent of Station B, Laclede Gas Light Co.

Tippy, B. O. October 16, 1901.
Detroit, Mich., Superintendent of the Detroit City Gas Co.

Tippy, Charles W. October 15, 1902.
Fulton, N. Y., General Manager of the Fulton Light and Fuel Co.

Titzel, C. Edgar. October 15, 1902.
Lancaster, Pa., Superintendent of the Lancaster Gas Light and Fuel Co.

Tobey, Franklin, Jr. October 19, 1892.
608 Broadway, Kingston, N. Y., Superintendent Kingston Gas and Electric Co.

Tompkins, John P. October 21, 1903.
Atlantic City, N. J., Secretary and General Manager of the Atlantic City Gas and Water Co.

Travis, F. M. October 17, 1900.
80 Crown street, New Haven, Conn., Treasurer of the New Haven Gas Light Co.

Tull, Lucien P. F. October 16, 1901.
340 Third avenue, New York, N. Y., Auditor of the New Amsterdam Gas Co.

Turner, Thomas. May 13, 1874.
224 Calhoun street, Charleston, S. C., P. O. Box 6.

Tuttle, William B. October 18, 1899.
168 Broadway, Long Branch, N. J., General Manager of the Consolidated Gas Co. of New Jersey.

Tyler, W. Graham. October 15, 1902.
3638 Chestnut street, Philadelphia, Pa., President of the Oskaloosa (Ia.) Gas Co. ; Treasurer of the Salem (N. J.) Gas Light Co.

* Vincent, G. I. October 15, 1902. October 21, 1903.
4427 Frankford avenue, Philadelphia, Pa., Superintendent Frankford District, Philadelphia Gas Works.

von Maur, Jacob D. October 21, 1903.
4469 Berlin avenue, St. Louis, Mo., Superintendent of Street Department, Laclede Gas Light Co.

Voorhis, A. M. October 17, 1894.
Broadway, Nyack, N. Y., P. O. Box 114, President, Treasurer and Manager of Nyack Gas Light and Fuel Co.

Wainright, Arthur V. October 15, 1902.
South Norwalk, Conn., P. O. Box 365, Superintendent of the Norwalk District of Connecticut Railway and Lighting Co.

Wakeman, E. A. October 19, 1898.
Batavia, N. Y., Superintendent Consolidated Gas and Electric Co.

Walbridge, H. D. October 17, 1894.
7 Wall street, New York, N. Y., President of the Pontiac (Mich.) Light Co.

Waldo, Charles S. October 20, 1886.
102 Milk street, Boston, Mass., P. O. Box 5331, Merchant, N. E. Agent for Baltimore Retort and Fire Brick Co.

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Wales, Harry B. October 19, 1898.
109 Ottawa street, Grand Rapids, Mich., Treasurer and Secretary Grand Rapids Gas Light Co.

Walker, Edwin M. October 18, 1899.
Bristol, Tenn.-Va., General Manager Bristol Gas and Electric Co.

Walker, M. Timmons. October 17, 1900.
207 Pine street, Fort Madison, Iowa, P. O. Box 202, General Manager Fort Madison Gas Light Co.

Walker, Sidney R. October 16, 1901.
401 Center street, Bay City, Mich., Superintendent of the Bay City Gas Co.

Walker, William L. October 21, 1903.
Fitchburg, Mass., Superintendent of Gas Department, Fitchburg Gas and Electric Light Co.

Wallace, Robert A. October 21, 1903.
151 Park street, N., Hamilton, Ont., Canada, Superintendent of Hamilton Gas Light Co.

* Walter, E. P. October 15, 1902. October 21, 1903.
6554 Germantown avenue, Germantown, Pa., Superintendent Germantown District, Philadelphia Gas Works.

Walters, Benj. S. October 17, 1900.
226 Western avenue, Blue Island, Ill., Manager Northwestern Gas Light and Coke Co.

Walton, Albert. October 15, 1902.
Auburn, N. Y., P. O. Box 250, Superintendent of the Citizens' Light and Power Co.

Waring, George H., Jr. October 16, 1901.
20th street and Lincoln avenue, Omaha, Neb., Superintendent of the Omaha Gas Co.

Warmington, Daniel R. October 21, 1891.
410 Pearl street, Cleveland, Ohio, Vice-President and General Manager of the People's Gas Light Co.

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Warmington, George H. May 13, 1874.
410 Pearl street, Cleveland, Ohio, President of the People's Gas Light Co.

Warner, George H. October 18, 1899.
1131 Broadway, New York, N. Y., Vice-President of Peekskill Gas Light Co.

Weaver, R. S. October 21, 1903.
Port Jervis, N. Y., General Manager of the Port Jervis Electric Light, Power, Gas and Railroad Co.

Weber, Adam. October 13, 1880.
Park Row Building, New York, N. Y., Adam Weber Sons.

Weber, Oscar B. October 17, 1883.
Park Row Building, New York, N. Y., Manager of Adam Weber Sons.

Wehner, Adolph F. October 17, 1894.
46 Bridge street, Newark, N. J., Secretary Isbell-Porter Co.

Wells, L. W. October 19, 1898.
137 East Fifth street, Canton, Ohio, Superintendent Canton Gas Light and Coke Co.

Welsh, Wm. J. October 15, 1902.
264 Bay street, Stapleton, N. Y., Assistant Superintendent of the New York and Richmond Gas Co.

Westcott, John T. October 18, 1893.
19 Abingdon street, Westminster, London, S. W., Eng., General Manager of the Economical Gas Apparatus Construction Co.; also 269 Front street, East, Toronto, Canada.

Wharton, W. S. October 17, 1900.
301 Holly street, Whatcom, Wash., General Manager Whatcom and Fairhaven Gas Co., Whatcom, Wash.

Wheeler, Fred. B. October 18, 1893.
30 Chenango street, Binghamton, N. Y., P. O. Box 653, General Manager Binghamton Gas Works.

Whipple, Henry S. October 19, 1898.
201 Mulberry street, Rockford, Ill., Superintendent Rockford Gas Light and Coke Co.

Whitaker, J. S. October 21, 1903.
Portsmouth, N. H., Superintendent of the Rockingham County Light and Power Co.

Whitcomb, Henry D., Jr. October 18, 1899.
575 Broad street, Newark, N. J., General Manager of Gas Department of Public Service Corporation of New Jersey.

White, Chas. E. October 18, 1899.
Yale avenue, Wakefield, Mass., Manager of Wakefield Municipal Light Plant.

White, Edwin C. October 21, 1903.
Long Branch, N. J., Superintendent of the Consolidated Gas Co. of New Jersey.

White, Edward D. October 17, 1883.
88 Van Dyke street, Brooklyn, N. Y., Director of Brooklyn Fire Brick Works.

White, Henry H. October 21, 1891.
23 North Illinois street, Belleville, Ill., P. O. Box 186, Superintendent of Belleville Gas Light and Coke Co.

White, Wm. Henry. April 16, 1873.
44 Broad street, New York, N. Y., Consulting Engineer and Contractor.

Whitney, Henry C. October 21, 1891.
Watertown, N. Y., President of Watertown Gas Light Co.

Whitson, John G. October 21, 1903.
Watsonville, Cal., President of the Watsonville Gas Co.

Whittaker, Alan Dean. October 19, 1898.
188 Ellison street, Paterson, N. J., Superintendent of Gas Department of the Paterson and Passaic Division, Public Service Corporation of New Jersey.

Whittier, Charles R. October 19, 1887.
10 Bridge street, New York, N. Y., Engineer of Westinghouse, Church, Kerr & Co.

Wilcox, John F. October 27, 1896.
Syracuse, N. Y., care of Semet-Solvay Co.

Williams, E. H. October 17, 1888.
Center and Leavenworth streets, Waterbury, Conn., P. O. Box 617, Agent and Superintendent of The United Gas Improvement Co.

Williams, Herbert G. October 16, 1901.
101 North Main street, Port Chester, N. Y., Superintendent of Westchester Lighting Co., Port Chester District.

Williams, L. S. October 19, 1898.
27 North 3d street, Harrisburg, Pa., Manager of Harrisburg Gas Co.

Williams, W. L. October 15, 1890.
183 Tyler street, Paterson, N. J., Superintendent of the Gas Department of the Paterson and Passaic Gas and Electric Co.

Williamson, John. October 18, 1893.
157 Michigan avenue, Chicago, Ill., Consulting Engineer of the People's Gas Light and Coke Co.

Wilson, W. A. October 21, 1903.
Portage, Wis., Superintendent of the Portage American Gas Co.

Witherby, Edwin E. October 19, 1898.
40 Wall street, New York, N. Y., General Manager United Gas and Electric Co.

Wolff, Samuel E. October 21, 1903.
260 Main street, East, Jackson, Mich., Secretary and General Manager of the Jackson Gas Co.

Wood, Austin C. April 16, 1873.
216 North West street, Syracuse, N. Y.

*Wood, Stuart. October 18, 1899. October 17, 1900.
400 Chestnut street, Philadelphia, Pa., Treasurer of the Macon Gas Light and Water Co.

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Wood, T. B. October 16, 1901.
Broad and Arch streets, Philadelphia, Pa., P. O. Box 1564, care of The United Gas Improvement Co.

Wood, Walter. October 19, 1881.
Millville, N. J., Manager of Millville Gas Light Co.

Wood, William A. October 16, 1889.
24 West street, Boston, Mass., Chief Engineer of Boston, Bay State, Roxbury and South Boston Gas Light Companies.

Woods, George E. October 20, 1897.
4 Irving place, New York City, Engineer of Manufacture of the Consolidated Gas Co.

Woodward, Ralph. October 19, 1898.
Pittsfield, Mass., General Manager of Pittsfield Coal Gas Co.

Woollen, A. L. October 15, 1902.
501 West 146th street, New York, N. Y.

Wortendyke, Ira F. October 27, 1896.
Janesville, Wis., Superintendent of New Gas Light Co.

Yorke, Eugene H. October 19, 1881.
40 West Commercial street, Portland, Me., Engineer of Portland Gas Light Co.

Young, Alfred W. October 15, 1902.
Knoxville, Tenn., Superintendent of the Knoxville Gas Light Co.

Young, James M. H. October 20, 1897.
Joplin, Mo., Superintendent Joplin Gas Co.

Young, John. October 18, 1882.
603 West Diamond street, Allegheny, Pa., Consulting Superintendent of the Allegheny Heating Co.

Young, Percy S. October 18, 1899.
776 Broad street, Newark, N. J., Comptroller of Public Service Corporation of New Jersey.

Young, Peter. October 21, 1885.
202 Lewis Building, Pittsburg, Pa., Secretary and Treasurer of the Conneaut Gas Co., Conneaut, Ohio.

Young, Richard R. October 16, 1901.
187 Main street, Passaic, N. J., Agent for the Public Service Corporation of New Jersey.

Young, Robert. October 20, 1875.
610 Wood street, Pittsburg, Pa., General Manager Consolidated Gas Co. of City of Pittsburg, including Allegheny and South Side.

Young, Robert, Jr. October 16, 1901.
Pittsburg, Pa., Gas Engineer.

Zeek, Charles F. October 15, 1890.
25 and 27 East Garden street, Pensacola, Fla., Superintendent of Pensacola Gas Co.

Zollikoffer, Oscar F. October 19, 1892.
49 West 54th street, New York, N. Y.

ASSOCIATE MEMBERS.

Alcott, Franklyn L. October 19, 1898.
Cleveland, Ohio, 2d Vice-President American Stove Co., Standard Lighting Co. Division—Perkins avenue.

Allen, Walter S. October 19, 1892.
New Bedford, Mass.

Atwater, Christopher G. October 19, 1898.
Sydney, Cape Breton, N. S., Superintendent of Coke Ovens, Dominion Iron and Steel Co.

Baldwin, Chas. H. October 16, 1901.
159 Franklin street, Boston, Mass., P. O. Box 2410, Manager of the National Meter Company, Manufacturers of Gas Engines and Water Meters.

Barbour, W. T. October 18, 1899.
Detroit, Mich., President of Detroit Stove Works.

Barrows, George Shattuck. October 16, 1901.
Gloucester City, N. J., Engineer of the Welsbach Light Co.

Bartlett, D. Lewis. October 19, 1898.
Baltimore, Md., General Manager of Bartlett, Hayward & Co., Manufacturers of Gas Works Apparatus.

Bassett, Frank A. October 16, 1901.
147 Milk street, Boston, Mass., New England Sales Agent of Righter & Marshall, of New York and Philadelphia.

Bayles, James C. October 19, 1898.
M. E., Ph.D., 41 Park Row, New York, N. Y., Consulting Engineer.

Behrend, Fritz. October 17, 1894.
54 Front street, New York, N. Y., Clay Gas Retort Importer.

Bernstein, S. October 16, 1901.
82 West Broadway, New York, N. Y., President of the S. Bernstein Co.

Boal, Stanhope. October 18, 1899.
Piqua, Ohio, Vice-President of Favorite Stove and Range Co.

Bower, William H. October 17, 1900.
Gray's Ferry Road and 29th street, Philadelphia, Pa., General Manager of the Chemical Works of the Ammonia Company of Philadelphia.

Brown, Frank H. October 19, 1892.
Waltham, Mass., Treasurer and Superintendent of Davis & Farnum Manufacturing Co.

Brownell, E. E. October 21, 1903.
Dayton, Ohio, Electrical Engineer.

Bunnell, Sterling H. October 15, 1902.
Lorain, Ohio, Manager of the Brown-Cochran Co.

Burchard, Lewis Sayre. October 16, 1901.
6 Wall street, New York, N. Y., President and Treasurer of the Webber Prepayment Attachment Co.

Carpenter, H. A. October 20, 1897.
Pittsburg, Pa., Engineer with Riter-Conley Mfg. Co.

Cartwright, Henry R. October 18, 1899.
N. W. corner 22d and Arch streets, Philadelphia, Pa., Manager American Meter Company (Philadelphia factory.)

Case, C. A. October 21, 1903.
Auburn Park, Chicago, Ill., General Solicitor for the Elgin American Gas Co.

Casey, Wm. J. October 17, 1900.
San Francisco, Cal., President of the Union Gas Engine Co.

Chaney, Franklin V. October 16, 1901.
28 Oliver street, Boston, Mass., Publisher of Gas Literature, Home Science Publishing Co.

Cheesman, Frank P. October 21, 1903.
92 William street, New York, N. Y., Partner, National Paint Works.

Coburn, Cyrus M. October 19, 1892.
Chelsea, Mass., Agent and Manager of Liberty Oil Co., house address, 61 Shurtleff street.

Coleman, H. W. October 19, 1898.
Land Title Building, Philadelphia, Pa., Partner of J. K. Dimmick & Co.

Collins, Warren. October 21, 1903.
Stamford, Conn., Representative of the Stamford Gas Stove Co.

Compton, Melvin D. October 15, 1902.
16 and 18 Park place, New York, N. Y., Vice-President and Treasurer of the Ball Check Light Co.

Cox, Edward L. October 21, 1903.
371 Fifth avenue, New York, N. Y., Traveling Salesman for the Oxley & Enos Manufacturing Co.

Crane, William M. October 16, 1889.
1131 Broadway, New York, N. Y., President Wm. M. Crane Co., Gas Stoves, etc.

Cressler, Alfred M. October 15, 1902.
Fort Wayne, Ind., Treasurer of the Kerr-Murray Manufacturing Co.

Cressler, George H. October 15, 1902.
Calhoun and Murray streets, Fort Wayne, Ind., Secretary of the Kerr-Murray Manufacturing Co.

Cruse, Arthur R. October 21, 1903.
1205-06 Stephen Girard Building, Philadelphia, Pa., President of the Cruse-Kemper Co.

DeHart, J. S., Jr. October 19, 1898.
46 Bridge street, Newark, N. J., Engineer with Isbell-Porter Co.

Dickel, Wm. L. October 16, 1901.
136 Liberty street, New York, N. Y., President of the Boulevard Globe and Lamp Co., Somerville, N. J.

Dickey, Edmund S. October 17, 1900.
Baltimore, Md., P. O. Box 773, with the Maryland Meter and Manufacturing Co.

Dods, John C. October 16, 1901.
Sulphur and Manchester avenues, St. Louis., Mo., Engineer with the Laclede Fire Brick Manufacturing Co.

Drummond, M. J. October 20, 1897.
192 Broadway, New York, N. Y., Manufacturer of Cast Iron Pipe.

Eaton, Alfred B. October 27, 1896.
70 Wabash avenue, Chicago, Ill., Western Sales Agent of The United Gas Improvement Co.

Fiske, John T. October 18, 1899.
Port Chester, N. Y., Salesman with Abendroth Bros.

Floyd, James R., Jr. October 19, 1898.
Newburgh, N. Y., care of Newburgh Light, Heat and Power Co.

Garrison, John J. October 21, 1903.
26 Cumberland street, Boston, Mass., Special Representative for Gas Department of Detroit Stove Works.

Genay, Thomas S. October 15, 1902.
Broad and Arch streets, Philadelphia, Pa., Chief Clerk in the General Superintendent's Department of The United Gas Improvement Co.

Gosnell, W. D. October 15, 1902.
201-203 Concord street, Baltimore, Md., Manufacturer of Purifying Trays.

Granger, W. R. October 21, 1903.
Montreal, Canada, General Manager of the Auer Incandescent Light Manufacturing Co., Limited.

Graves, George W. October 20, 1897.
32 South avenue, Rochester, N. Y., Salesman with Abendroth Bros.

Gregg, Frank M. October 15, 1902.
1800 East Madison avenue, Cleveland, Ohio, Treasurer and General Manager of the Cleveland Vapor Light Co.

Gribbel, Wm. S. October 18, 1899.
52 Dey street, New York, N. Y., Agent of John J. Griffin & Co.

Harper, H. D. October 17, 1900.
Jefferson and Monroe streets, Chicago, Ill., Chicago Agent of D. McDonald & Co.

Hayward, Sterling F. October 15, 1890.
395 Broadway, New York, N. Y., Secretary and Treasurer of Connelly Iron Sponge and Governor Co.

Henderson, E. H. October 27, 1896.
Address unknown.

Higgins, C. M. October 21, 1891.
26 Broadway, New York, N. Y., with Standard Oil Co.

Hinman, Charles W. October 27, 1896.
8 Medford street, Boston, Mass., with Nathaniel Tufts Meter Co.

Hunter, Harry W. October 16, 1901.
851 Equitable Building, Baltimore, Md., Salesman of F. & L. Kahn & Bros., Hamilton, Ohio.

Jacobs, Charles H. October 20, 1897.
3d and Larned streets, Detroit, Mich., Secretary, Treasurer and General Superintendent of Detroit Meter Co.

Johnston, E. D. October 17, 1900.
Connersville, Ind., President and General Manager of P. H. & F. M. Roots Co.

Kahn, Lazard. October 15, 1902.
Hamilton, Ohio, F. & L. Kahn & Bros., Manufacturer of Gas Appliances.

Kellum, Benjamin J. October 21, 1903.
68 and 70 Wabash avenue, Chicago, Ill., Manager of the Welsbach Co.

Kenah, R. L., Jr. October 15, 1902.
Penn avenue, New Brighton, Pa., P. O. Box 315, Treasurer and General Manager of the Pierce-Crouch Engine Co. and President and Treasurer of the Pittsburg Machine Co.

Latta, M. Nisbet. October 17, 1900.
Charlotte, N. C., Superintendent Charlotte Electric Railway, Light and Power Co.

Leakey, Nathan G. October 16, 1901.
Detroit, Mich., Assistant Secretary of the Michigan Ammonia Works.

Lindsay, Charles R. October 21, 1903.
170 Lake street, Chicago, Ill., Lindsay & Co.

Lippincott, Wilbur M. October 16, 1901.
55 Park place, New York, N. Y., Salesman of the American Incandescent Lamp Co.

Little, George B. October 19, 1892.
85 Water street, Boston, Mass.

Luqueer, Robert O. October 18, 1899.
M. E., 31 Nassau street, New York, N. Y., Assistant Engineer of Humphreys & Glasgow.

McDonald, Albert. October 15, 1902.
Erie, Pa., Superintendent of the Metric Metal Works.

McDonald, Donald. October 21, 1891.
51 Lancaster street, Albany, N. Y., Manager of D. McDonald & Co.

McIlravy, W. N. October 16, 1901.
17 Battery place, New York, N. Y., Agent of the National Coal Tar Co.

McIntire, John K. October 18, 1899.
116 N. Main street, Dayton, Ohio, President of Third National Bank.

McNary, J. B. October 21, 1903.
Windsor, Ontario, Canada, Manager of the Canadian Meter Co.

Manring, J. L. October 15, 1902.
Middlesborough, Ky., Vice-President and General Manager of the Fork Ridge Coal and Coke Co.

Marsh, Converse D. October 16, 1901.
136 Liberty street, New York, N. Y., President of Bryan-Marsh Co., Manufacturers of Photometers.

Mason, Sidney. October 21, 1903.
Philadelphia, Pa., President of the Welsbach Light Co., United Gas Improvement Building.

Miller, Robert S. October 15, 1902.
Sterling, Ill., care of Sterling Gas and Electric Light Co.

Mills, Wm. A. October 16, 1901.
Port Chester, N. Y., P. O. Drawer C, President of Abendroth Bros.

Mordue, Thomas N. October 16, 1895.
Old Colony Building, Chicago, Ill., Agent Castner, Curran & Bullitt.

Mueller, Robert. October 17, 1900.
College and Cerro Gordo streets, Decatur, Ill., Secretary of H. Mueller Manufacturing Co.

Nichols, Carroll B. October 16, 1901.
224 South 3d street, Philadelphia, Pa., Salesman of the Westmoreland Coal Co.

Nicoll, John F. October 21, 1903.
Otto, Pa., Assistant to President of the American Coke and Gas Construction Co.

Norton, Arthur E. October 18, 1899.
8 Medford street, Boston, Mass., Representing Nathaniel Tufts Meter Co.

Norton, Harry A. October 17, 1888.
8 Medford street, Boston, Mass., Manager Nathaniel Tufts Meter Co.

Osborne, Willard B. October 19, 1898.
Pittsburg, Pa., care of Riter-Conley Manufacturing Co.

Osius, George. October 16, 1889.
Detroit, Mich., Secretary and Treasurer of Michigan Ammonia Works.

Page, Albion L. October 21, 1891.
180 Fulton street, New York, N. Y., of Geo. Shepard Page's Sons.

Palmer, George Q. October 16, 1901.
742 E. 12th street, New York, N. Y., Manager of the Quintard Iron Works.

Parker, George W. October 21, 1903.
45 Broadway, New York, N. Y., Eastern Agent for the Parker-Russell Mining and Manufacturing Co.

Pattison, Melvin. October 21, 1903.
Cleveland, Ohio, Representative of the Brown Hoisting Machinery Co.

Payne, Frank H. October 17, 1900.
Erie, Pa., P. O. Box 710, Manager of the Metric Metal Works.

Pearson, Joshua Ash. October 20, 1897.
Broad and Arch streets, Philadelphia, Pa., Purchasing Agent The United Gas Improvement Co.

Persons, Fred. R. October 17, 1888.
430 Superior street, Toledo, Ohio, Representative of Maryland Meter Co.

Piser, Theodore Halstead. October 15, 1902.
68 Franklin street, Boston Mass., Manager of Welsbach Co., New England Department.

Plantinga, Pierre. October 15, 1902.
720–722 Citizens' Building, Cleveland, Ohio, President of The Gas Machinery Co.

Platt, E. S. October 27, 1896.
Room 218, Commercial Building, St. Louis, Mo., Secretary and Treasurer of George Platt & Co.

Potter, T. J. October 16, 1901.
130 Anawan avenue, West Roxbury, Mass., New England Representative of Wm. M. Crane Co.

Prendergast, Daniel J. October 20, 1897.
33 Nassau street, New York, N. Y., General Superintendent Welsbach Street Lighting Company of America.

Rancke, Louis N. October 21, 1903.
Hull and Nicholson streets, Locust Point, Baltimore, Md., Superintendent of the Baltimore Retort and Fire Brick Co.

Roberts, Clarence V. October 16, 1901.
257–259 N. Front street, Philadelphia, Pa., President of the Roberts and Mander Stove Co.

Rodgers, E. H. October 16, 1901.
1434 Randolph street, Philadelphia, Pa., President of the Standard Meter Co.

Sadtler, J. P. B. October 18, 1899.
231 Park avenue, Baltimore, Md., Senior Member of firm of J. P. B. Sadtler & Co.

Schumacher, Gerard. October 21, 1903.
116 Nassau street, New York City, Second Vice-President of the Central Foundry Co.

Schutt, Henry L. October 15, 1902.
32 Linden avenue, Buffalo, N. Y., Salesman of Wm. M. Crane Co.

Steinwedell, W. E. October 15, 1902.
720–722 Citizens' Building, Cleveland, Ohio, Secretary of the Gas Machinery Co.

Steward, Robert Bruce. October 18, 1899.
Chattanooga, Tenn., Vice-President of the D. M. Steward Manufacturing Co.

Stratton, S. S. October 16, 1889.
88–92 West Jackson Boulevard, Chicago, Ill., Agent Maryland Meter Co.

Taylor, Horace G. October 18, 1899.
M. E., 38 Victoria street, London, S. W., England, Assistant Engineer of Humphreys & Glasgow.

Terhune, Charles F. October 16, 1901.
1133 Broadway, New York, N. Y., Vice-President of Wm. M. Crane Co.

Tolman, Wm. Nichols. October 17, 1900.
22d and Filbert streets, Philadelphia, Pa., Engineer of Construction, Station B, Philadelphia Gas Works, The United Gas Improvement Co.

Trenkamp, H. J. October 19, 1898.
Cleveland, Ohio, Secretary of the Schneider & Trenkamp Co.

Van Wie, Edwin G. October 27, 1896.
Detroit, Mich., Manager Gas Appliance Department, Detroit Stove Works.

Warren, Henry J. October 21, 1903.
Stamford, Conn., President of the Stamford Gas Stove Co.

Webber, Wesley. October 16, 1901.
6 Wall street, New York, N. Y., Engineer of the Webber Prepayment Attachment Co.

Wehner, R. K. October 17, 1898.
46 Bridge street, Newark, N. J., Treasurer of Isbell-Porter Co.

Welch, John S. October 16, 1901.
N. W. corner Broad and Arch streets, Philadelphia, Pa., Gas Engine Expert with The United Gas Improvement Co.

Wells, Fred. K. October 27, 1896.
356 Fourth avenue, New York, N. Y., Manager Eastern Office, George M. Clark & Co. of Chicago.

Wharton, Henry. October 16, 1895.
224 South 3d street, Philadelphia, Pa., Assistant Secretary Westmoreland Coal Co.

Wickham, Leigh. October 16, 1901.
417 Pine street, St. Louis, Mo., Agent of the Parker-Russell Mining and Manufacturing Co.

Wilbraham, John S. October 19, 1892.
2518 Frankford avenue, Philadelphia, Pa., Secretary and Treasurer of Wilbraham-Baker Blower Co.

Wilbraham, John W. October 19, 1892.
2518 Frankford avenue, Philadelphia, Pa., President of Wilbraham-Baker Blower Co.

Wilkin, John T. October 21, 1903.
Connersville, Ind., Mechanical Engineer of the Connersville Blower Co.

Wood, Edward R., Jr. October 17, 1900.
400 Chestnut street, Philadelphia, Pa., with R. D. Wood & Co.

Zwisler, A. L. October 21, 1903.
Kalamazoo, Mich., Salesman for the General Gas Light Co.

JUNIOR MEMBERS.

Allison, Walter A. October 21, 1903.
2142 Sedgley avenue, Philadelphia, Pa., Foreman of Mains and Services, Philadelphia Gas Works, Spring Garden District.

Bucher, Paul. October 21, 1903.
155 Railroad avenue, White Plains, N. Y., Assistant to the Superintendent of the Westchester Lighting Co.

Burnett, Frederick. October 21, 1903.
269 Front street, East, Toronto, Canada, Assistant to L. L. Merrifield, Economical Gas Apparatus Construction Co.

Butler, J. F. October 21, 1903.
Ardmore, Pa., Cadet Engineer, Merion and Radnor Gas and Electric Co.

Cadwallader, Lacey L. October 21, 1903.
408 Lyceum avenue, Roxborough, Philadelphia, Pa., Foreman of Mains and Services, Philadelphia Gas Works.

Calkins, W. B. October 21, 1903.
St. Louis, Mo., Chief Chemist of the Laclede Gas Light Co.

Castor, William A. October 21, 1903.
1646 Dyre street, Frankford, Pa., Assistant Superintendent City District, Philadelphia Gas Works.

Christy, Henry B. October 21, 1903.
1308 Arrott street, Frankford, Philadelphia, Pa., Assistant Foreman of Mains and Services, Philadelphia Gas Works.

Dunne, Philip. October 21, 1903.
1931 South Ninth street, Philadelphia, Pa., Foreman of Fitters, Philadelphia Gas Works.

Fitzpatrick, Dan. October 21, 1903.
St. Augustine, Fla., Machinist and Foreman of Works, St. Augustine Gas and Electric Light Co.

Forbes, Walter. October 21, 1903.
Chattanooga, Tenn., Foreman Chattanooga Gas Light Co.

Fowler, Joseph W. October 21, 1903.
16 East Forsythe street, Jacksonville, Fla., Assistant Superintendent of the Citizens' Gas Co.

Frick, John Arthur. October 21, 1903.
Philadelphia, Pa., Street Clerk, Philadelphia Gas Works.

Fulweiler, Walter Herbert. October 21, 1903.
1st and Combell streets, Kansas City, Mo., Cadet Engineer with the Kansas City Missouri Gas Co.

Gillingham, Hubert D. October 21, 1903.
4529 Pulaski avenue, Germantown, Philadelphia, Pa., Foreman of Mains and Services, Germantown District, Philadelphia Gas Works.

Graham, L. C. October 21, 1903.
5715 Ashland avenue, Philadelphia, Pa., Foreman of Mains and Services, West Philadelphia District, Philadelphia Gas Works.

Green, Albert. October 21, 1903.
4518 Tacony street, Frankford, Philadelphia, Pa., Foreman of Fitters of the Philadelphia Gas Works.

Hammond, Eric W. October 21, 1903.
Llanwellyn P. O., Delaware County, Pa., Street Clerk, Philadelphia Gas Works.

Johnston, Ernest. October 21, 1903.
St. Augustine, Fla., Chief Clerk, St. Augustine Gas and Electric Light Co.

Kellogg, R. M. October 21, 1903.
119 Woodworth avenue, Yonkers, N. Y., Cadet Engineer with the Westchester Lighting Co.

Keppleman, D. Ellwood. October 21, 1903.
3729 North Carlisle street, Philadelphia, Pa., Foreman of Fitters, Spring Garden District, Philadelphia Gas Works.

Laubenstein, A. R. October 21, 1903.
1946 North 23d street, Philadelphia, Pa., Assistant to Superintendent of Meters, Philadelphia Gas Works.

Lucena, Joseph. October 21, 1903.
3650 Market street, Philadelphia, Pa., Foreman of Fitters, West Philadelphia District, Philadelphia Gas Works.

Macbeth, George T. October 21, 1903.
119 Woodworth avenue, Yonkers, N. Y., Works Foreman, Westchester Lighting Co.

Morgan, J. E. October 21, 1903.
Mount Vernon, N. Y., Cadet Engineer with the Westchester Lighting Co.

Myler, J. A., Jr. October 21, 1903.
P. O. Box No. 39, Mamaroneck, N. Y., Foreman of Special Mains, Westchester Lighting Co.

Parker, John C. October 21, 1903.
127 Seymour street, Germantown, Philadelphia, Pa., Assistant Service Foreman, Germantown District, Philadelphia Gas Works.

Parker, Joseph Smith. October 21, 1903.
2003 South Cleveland avenue, Philadelphia, Pa., Foreman of Mains, Philadelphia Gas Works.

Price, William H. October 21, 1903.
Lakewood, Kent County, R. I., Clerk with the Providence Gas Co.

Roberts, F. M. October 21, 1903.
Main and Adee streets, Port Chester, N. Y., Assistant to the Superintendent of the Westchester Lighting Co.

Schauer, Frank F. October 21, 1903.
2157 North Van Pelt street, Philadelphia, Pa., Foreman of Mains, Frankford District, Philadelphia Gas Works.

Skinner, Samuel. October 21, 1903.
177 Harbor street, Montreal, P. Q., Canada, Superintendent of Gas Department of the Montreal Light, Heat and Power Co.

Terry, H. W., Jr. October 21, 1903.
215 South Third avenue, Mount Vernon, N. Y., Chemist and Cadet Engineer with the Westchester Lighting Co.

Tinsman, E. H. October 21, 1903.
Lumberville, Pa.

Umstead, Elmer S. October 21, 1903.
1934 North Gratz street, Philadelphia, Pa., Foreman of Services, Philadelphia Gas Works.

Williams, Thomas G. October 21, 1903.
1931 South Ninth street, Philadelphia, Pa., Foreman of Street Leaks, Philadelphia Gas Works.

SUMMARY OF CLASSES OF MEMBERSHIP.

Honorary Members	12
Active Members	629
Associate Members	120
Junior Members	36
Total	797

MEMBERS OF THE AMERICAN GAS LIGHT ASSOCIATION ARRANGED GEOGRAPHICALLY.

ALABAMA.

Birmingham.....J. T. B. Cocke ..... 2104 1st avenue
Ensley.....A. F. Hilleke.

ARKANSAS.

Pine Bluff.....L. I. Pollitt.

CALIFORNIA.

Los Angeles.....W. B. Cline.....645 South Hill street
J. J. Davis..305 Conservative Life Building
Napa .....T. R. Parker.....105 Division street
Oakland .....John A. Britton.
Pasadena .....T. S. C. Lowe.
San Francisco ...Wm. J. Casey.
Joseph B. Crockett.....415 Post street
Walter S. Dole.....321 Market street
Frederick H. Eichbaum..101 Devisadero st.
Edward C. Jones.....630 Rialto Building
C. O. G. Miller .....455 Sutter street
Vallejo .....John W. Thomas.
Watsonville .....John G. Whitson.

COLORADO.

Canon City.....J. D. Taylor, Jr.
Colorado Springs.Ira Abbott Miller....111 East Kiowa street
Denver .....J. Charles Andrews .....405 17th street
Philip Cross.....405 17th street
Frank W. Frueauff .....405 17th street
Pueblo.....Wm. C. Paullins.

CONNECTICUT.

Bridgeport	Charles F. Bryant.	
Danbury	Charles H. Merritt	350 Main street
Derby	Charles H. Nettleton.	
	George H. Scranton.	
Hartford	John P. Harbison	700 Main street
	John W. Hatstat.	
Meriden	Charles A. Learned	40 Colony street
New Britain	Everett C. Learned	118 Maple street
	Andrew J. Sloper	25 West Main street
	F. L. Terry.	
New Haven	J. A. Norcross	80 Crown street
	F. C. Sherman	80 Crown street
	F. M. Travis	80 Crown street
New London	Frank M. Tait	29 Main street
Norwich	A. J. Campbell.	
	George B. Leland.	
South Norwalk	A. V. Wainright.	
Stamford	Warren Collins.	
	Walter M. Jackson	9 Oliver street
	H. J. Warren.	
Waterbury	D. L. Summey, Center and Leavenworth sts.	
	E. H. Williams, Center and Leavenworth sts.	
Winsted	Rufus E. Holmes.	

DELAWARE.

Wilmington	J. Edward Addicks.	
	W. Frank Bailey.	
	Thomas Curley	827 Market street

DISTRICT OF COLUMBIA.

Washington	C. Clay Bayly	26th and G streets
	Frederic Egner	Corner G and 12th streets
	Thos. F. Holden	12th and M streets, S. E.
	John Leetch	1409 31st street
	James S. McIlhenny	26th and G sts., N.W.
	John R. McLean	413 10th street, N.W.
	Robert L. Middleton	1411 30th street, N.W.

FLORIDA.

Gainesville	Geo. I. Doig.	
Jacksonville	Dan J. Dougherty.	
	J. W. Fowler	16 E. Forsythe street
	Clarence S. Hammatt	1027 Main street
Pensacola	Charles F. Zeek	25–27 E. Garden street
St. Augustine	Dan Fitzpatrick.	
	Ernest Johnston.	
	George Old	210 St. George street
Tampa	A. J. Boardman	Roberts Building

GEORGIA.

Atlanta	W. L. Cosgrove	Alabama and Broad streets
	F. B. Crowell	38 Thurmond street
Augusta	Wm. B. Miller.	
Columbus	MacDougald Dexter	1116 Second avenue
	James Ferrier	1149 Broad street
Savannah	John W. Golden	9 Congress street
	S. E. Linton, Jr.	

TERRITORY OF HAWAII.

Honolulu	Alonzo Gartley	223–225 King street

ILLINOIS.

Alton	J. F. Porter	205 Market street
Aurora	I. C. Copley.	
Belleville	Henry H. White	23 North Illinois street
Blue Island	B. S. Walters	226 Western avenue
Cairo	John W. Eakin	709 Ohio Levee street
Chicago	W. I. Battin	635 West 62d street
	Ernest W. Bell	245 East 61st street
	C. A. Case	Auburn Park
	A. B. Eaton	70 Wabash avenue
	John H. Eustace	Adams st. & Michigan ave.
	Chas. H. Evans	523 Rialto Building
	A. R. Foote	625 Home Insurance Building
	C. H. Geist	619 New York Life Building

Chicago	H. D. Harper	Jefferson and Monroe streets
	B. J. Kellum	70 Wabash avenue
	C. R. Lindsay	170 Lake street
	Carroll Miller	155 Michigan avenue
	Thomas N. Mordue	Old Colony Building
	J. M. Morehead	157 Michigan avenue
	M. A. Norland	157 Michigan avenue
	T. V. Purcell	Ashland Block
	Rudolph Schenck	157 Michigan avenue
	S. S. Stratton	88 & 92 W. Jackson Boulevard
	George Summers	28 Lincoln avenue
	John Williamson	157 Michigan avenue
Decatur	Robert Mueller	College & Cerro Gordo sts.
Elgin	Carl H. Dunbar	Spring and Milwaukee sts.
Evanston	Rufus C. Dawes	1611 Benson avenue
Galesburg	Charles L. Gerould.	
Oak Park	Edward E. Morrell	221 Wesley avenue
Peoria	F. W. Little	125 North Jefferson avenue
Rockford	George D. Roper.	
	Henry S. Whipple	201 Mulberry street
Springfield	George H. Dawson.	
Sterling	Robert S. Miller.	
Waukegan	Geo. F. Goodnow.	

INDIANA.

Connersville	E. D. Johnston.	
	J. T. Wilkin.	
Evansville	Edward J. Elles.	
Fort Wayne	Alfred D. Cressler	Calhone and Murray sts.
	Alfred M. Cressler.	
	George H. Cressler	Calhone and Murray sts.
	Olaf N. Guldlin	535 West Berry street
	G. Max Hofman.	
	C. S. Knight.	
	A. B. Slater, Jr.	
Indianapolis	James Somerville.	Cor. Penn & Louisiana sts.
New Albany	James W. Dunbar	507 Bank street
Peru	W. V. Spinning	12 West 3d street
Terre Haute	M. N. Diall	636 Main street

IOWA.

Burlington ..... Edward D. Clary ..... 914 North 6th street
Clinton ..... S. M. Highlands.
Des Moines ..... Jansen Haines ..... 417 Locust street
Dubuque ..... George McLean ..... 669 Main street
Fort Dodge ..... Wm. M. Healy.
Fort Madison .... M. Timmons Walker ..... 207 Pine street
Oskaloosa ..... William Bailey .... 216 High avenue, West
Ottumwa ..... H. B. Maynard.
Sioux City ..... L. L. Kellogg ..... 528 Fifth street

KANSAS.

Kansas City ..... Northrop Moore.
Leavenworth .... Edward S. Springer.

KENTUCKY.

Louisville ..... A. H. Barret.
Donald McDonald.
Middlesborough . J. L. Manring.

LOUISIANA.

New Orleans .... Thos. D. Miller .. Baronne and Common sts.

MAINE.

Bangor ..... Charles E. Dole.
Vernon K. Gould ..... 18 Central street
Portland ..... George F. Duncan ..... 42 Exchange street
Wm. H. Moulton ..... 9 Temple street
Eugene H. Yorke .. 4 W. Commercial street

MARYLAND.

Baltimore ..... Edward L. Bartlett . McHenry and Scott sts.
D. Lewis Bartlett.
George Beadenkopf .. 5 W. Baltimore street
Charles H. Dickey . North and Saratoga sts.
Edmund S. Dickey.
W. D. Gosnell ..... 201 Concord street

Baltimore	Francis H. Hambleton. 5 W. Baltimore street
	Thomas J. Hayward. McHenry & Scott sts.
	Harry W. Hunter. .851 Equitable Building
	Frederick J. Mayer. McHenry and Scott sts.
	E. B. Meginniss. 2102 North Charles street
	N. T. Meginniss ..... Equitable Building
	A. S. Miller..... 5 W. Baltimore street
	E. T. Powers ..... 5 W. Baltimore street
	Louis N. Rancke. Hull and Nicholson streets
	J. P. B. Sadtler..... 231 Park avenue
Frederick	Richard C. Congdon..... Record street

MASSACHUSETTS.

Boston	Forrest E. Barker. .State House, Room 145
	Chas. H. Baldwin..... 159 Franklin street
	Frank A. Bassett..... 147 Milk street
	Albert C. Burrage..... 24 West street
	Chas. D. Burrage..... 85 Ames Building
	Franklin V. Chaney..... 28 Oliver street
	Arthur E. Childs..... 131 State street
	Robert F. Fitz.
	J. J. Garrison ..... 26 Cumberland street
	John A. Gould. 100 Boylston st., Room 1031
	William H. Hill..... 40 Water street
	C. W. Hinman ..... 8 Medford street
	George B. Little ..... 85 Water street
	Arthur E. Norton ..... 8 Medford street
	Harry A. Norton ..... 8 Medford street
	Theodore H. Piser..... 68 Franklin street
	F. P. Royce..... 159 Devonshire street
	Charles H. Sprague..... 70 Kilby street
	C. H. Tenney..... 159 Devonshire street
	Charles S. Waldo..... 102 Milk street
	William A. Wood..... 24 West street
Cambridgeport	Geo. F. M'Caffrey ..... 1 Putnam court
Charlestown	Patrick Coyle ..... 27 Arlington avenue
	Samuel J. Fowler..... Thompson square
Chelsea	Cyrus M. Coburn.
	George W. Moses.

Chicopee	Charles H. Nutting	37 Gaylord street
East Boston	Nathaniel W. Gifford.	
East Cambridge	Horace A. Allyn	Third street
Everett	Clarence S. Lomax	25 Pleasant street
Fall River	Chas. F. Leonard	14 Bedford street
	Joseph E. Nute	14 Bedford street
Fitchburg	H. F. Coggshall	374 Main street
	William L. Walker.	
Gloucester	John A. Coffin	Duncan street
Holyoke	William H. Snow.	
Jamaica Plain	Eugene N. Foss	8 Everett street
Lawrence	Fred. H. Sargent	370 Essex street
Lowell	Geo. S. Motley.	
Lynn	Charles F. Prichard	90 Exchange street
Marlboro	G. F. Macmun.	
	C. W. Morse	Corey Building
Medford	Frank E. Chandler.	
Milton	Wm. E. MacKay	Dudley Road
New Bedford	Walter S. Allen.	
Newton	Waldo A. Learned	2 Jewett street
North Adams	Frank S. Richardson	84 Main street
Northampton	H. C. Crafts	212 Main street
Pittsfield	Ralph Woodward.	
Springfield	Charles F. Day.	
	F. de V. Thompson	123 State street
Wakefield	Charles E. White	Yale avenue
Waltham	Frank H. Brown.	
	Fred. J. Davis.	
	Charles F. Spaulding	Townsend street
West Roxbury	T. J. Potter	130 Anawan street
Worcester	Charles D. Lamson	240 Main street

MICHIGAN.

Ann Arbor	Henry W. Douglas	211 Huron street
Bay City	Sidney R. Walker	401 Center street
Delray	Wm. H. Frost	1998 River street
Detroit	Wareham S. Baldwin.	
	W. T. Barbour.	
	Isaac C. Baxter.	

Detroit	Irvin Butterworth	230 Woodward avenue
	Paul Doty	230 Woodward avenue
	Carl H. Graf	402 Union Trust Building
	Charles H. Jacobs	3d and Larned streets
	Nathan G. Leakey.	
	Ernest F. Lloyd	860 Greenwood avenue
	George Osius.	
	Frank Kerr Pelton	402 Union Trust Bldg.
	B. O. Tippy.	
	E. G. Van Wie.	
Grand Rapids	W. H. Barthold.	
	W. M. Eaton.	
	Harry B. Wales	109 Ottawa street
Jackson	Samuel E. Wolff	260 Main street, E.
Kalamazoo	Walter M. Blinks.	
	Frank W. Blowers	147 South Burdick st.
	J. J. Knight	123 South West street
	A. L. Zwisler.	
Pontiac	William H. Morgans	11 South Saginaw st.
Port Huron	Jas. T. Lynn	402 Union Trust Bldg.
Saginaw	Bernard C. Cobb.	
Wyandotte	Harry T. Ammon.	

MINNESOTA.

Red Wing	W. R. Putnam.	
St. Paul	A. P. Lathrop. N. W. cor. 6th & Jackson sts.	
	Ernest E. Eysenbach, N. W. corner 6th and Jackson streets.	

MISSOURI.

Carthage	Don C. Brainard.	
Independence	George C. Danforth.	
Joplin	Jas. M. H. Young.	
Kansas City	George S. Clarke	10th and Walnut streets
	W. H. Fulweiler	1st and Combell streets
	Robert Macmillan	931 Walnut street
	Mastin Simpson	730 Delaware street
St. Joseph	Kerr M. Mitchell	8th and Francis streets

St. Louis	Wm. A. Baehr	716 Locust street
	W. B. Calkins.	
	Byron E. Chollar	714 Locust street
	John C. D. Clark	716 Locust street
	E. G. Cowdery	716 Locust street
	A. J. Daly	2659 Adams street
	John Dell	411 Oliver street
	John C. Dods.	Manchester and Sulphur aves.
	James Green.	Manchester and Sulphur aves.
	E. S. Platt	218 Commercial Building
	Alexander Ross	716 Locust street
	Daniel R. Russell	417 Pine street
	Orrell O. Thwing.	Main and Howard streets
	Jacob D. von Maur	4469 Berlin avenue
	Leigh Wickham	417 Pine street
Springfield	P. A. Bertrand.	

NEBRASKA.

Omaha	Isaac Battin	1224 Farnum street
	G. W. Clabaugh	1224 Farnum street
	George H. Waring, Jr.,	20th st. and Lincoln avenue

NEW HAMPSHIRE.

Concord	H. K. Morrison	5 Capitol street
Dover	H. L. Shepherd.	
Keene	G. M. Rossman	18 Roxbury street
Manchester	Walter G. Africa	39 Hanover street
Nashua	Walter F. Norton.	9 Courtland street
Portsmouth	J. S. Whitaker.	

NEW JERSEY.

Asbury Park	J. M. Coles	619 Mattison avenue
Atlantic City	Savery Bradley.	
	J. P. Tompkins.	
Belmar	Thos. Baumgardner.	
Camden	Theo. Bunker.	418 Federal street
	Geo. W. Curtis.	
	J. R. Gilkyson	418 Federal street

Dover	Addison Ely, Jr.	Sussex street
East Orange	John A. Clark, Jr.	260 North Park street
Elizabeth	Francis Engel.	
	A. F. Reitemeyer	1088 Elizabeth avenue
Gloucester City	Geo. Shattuck Barrows.	
Harrison	J. C. Norcross.	
Hoboken	John Cabot	1412 Adams street
	Herbert H. Ferris	13th and Clinton streets
	J. W. Grace	13th street and Willow ave.
Jersey City	West Bissell	cor. 6th and Provost streets
	Edwin R. Case	15 Exchange place
	David R. Daly	Green and Essex streets
	E. J. Donahue	6th and Provost streets
	Dudley D. Flemming	249 Washington street
	H. V. Patterson	6th and Provost streets
Keyport	H. W. Davies	730 Broad street
Long Branch	C. Henry Irwin	196 Union avenue
	William B. Tuttle	168 Broadway
	E. C. White.	
Millville	Walter Wood.	
Montclair	A. E. Forstall.	
Newark	William H. Allen	575 Broad street
	John H. Braine	37 Lombardy street
	J. S. DeHart, Jr.	46 Bridge street
	J. P. Dusenberry	776 Broad street
	John C. Eisele	164 Market street
	Mervyn E. Johnston	776 Broad street
	Wm. H. Pettes	575 Broad street
	Alexander H. Strecker	575 Broad street
	J. Hawley Taussig.	
	A. F. Wehner	46 Bridge street
	R. K. Wehner	46 Bridge street
	H. D. Whitcomb, Jr.	575 Broad street
	P. S. Young	776 Broad street
New Brunswick	Samuel C. Gowen.	
Newton	W. O. Brown.	
	John Collins	180 Main street
Ocean City	Oscar H. Fogg.	
Passaic	C. A. Stelling.	

Passaic	Richard R. Young	187 Main street
Paterson	W. H. Rogers	188–190 Ellison street
	Alan Dean Whittaker	188 Ellison street
	W. L. Williams	183 Tyler street
Princeton	James E. Burke.	
Red Bank	Chas. W. Bennett	27 East Front street
Rutherford	Addison Ely.	
South Amboy	Wm. Stephenson.	
Trenton	Frank D. Moses	147 East State Street
	Richard Stockton.	
Vineland	A. H. Merritt.	

NEW YORK.

Albany	Frank S. Dunn	1131 Broadway
	Donald McDonald	51 Lancaster street
	William McDonald	51 Lancaster street
	Frank N. Sisson	51 Maiden lane
Amsterdam	William H. Cooper	33 Market street
Auburn	Willard E. Case.	
	C. D. Robison	122 Genesee street
	Albert Walton.	
Batavia	E. A. Wakeman.	
Binghamton	Robert W. Manier	40 Chenango street
	Fred. B. Wheeler	30 Chenango street
Brooklyn	Fred. S. Benson.	Kent avenue and Cross st.
	Robert W. Bush.	12th st. & Gowanus Canal
	Edward J. Byrne	5th and Hoyt streets
	Thomas E. Byrne.	1st avenue and 55th street
	Charles H. Corbett	428 Lafayette avenue
	James J. Humphreys, Jr	Coney Island
	James H. Jourdan	Nevins and Degraw sts.
	John D. Logan.	
	William J. Logan.	
	Edwin Ludlam	180 Remsen street
	Charles L. Rowland	102 Green street
	Henry C. Slaney	466 6th street
	Edward D. White	88 Van Dyke street
Buffalo	John J. Clahan	68 West Tupper street
	J. T. Herron	186 Main street

Buffalo	Richard M. Parker	186 Main street
	William S. Riselay	188 Main street
	Henry L. Schutt	32 Linden avenue
Corning	Frank D. Kingsbury	8 East Market street
	E. B. Seymour	54 East Market street
Elmira	S. N. Blake	501 Realty Building
Flushing	C. G. M. Thomas	150 Franklin place
Fulton	Charles W. Tippy.	
Glens Falls	Edwin M. Cashion.	
Hempstead	Vaughn W. Duke.	
Hornellsville	C. A. Schwarm.	
Ilion, Herkimer Co.	John A. Giblin	10 East Main street
	J. W. Planck	3 First street
	Thomas Ringwood	4 Armory street
Johnstown	L. D. Spragle	210 West Main street
Kingston	Franklin Tobey, Jr	608 Broadway
Little Falls	Henry P. Collins.	
Lockport	R. E. Slade	109 Main street
Long Island City.	Clifford S. Fox.	
	W. F. Lawrence.	
Mamaroneck	J. A. Myler, Jr.	
Middletown	William J. Max	17 Mulberry street
Mt. Vernon	W. B. Clements.	
	J. E. Morgan.	
	Albert Rosenthal	123 South 8th avenue
	Robert M. Searle	250 South 10th avenue
	F. A. Stratton.	
	H. W. Terry, Jr	215 South 3d avenue
Newburgh	Rolland A. Davidson.	
	Jas. R. Floyd, Jr.	
	Benjamin J. Macdonald	296 Grand street
New Rochelle	W. L. Secord	72 Washington avenue
New York	Frederick P. Addicks	52 Broadway
	Walter R. Addicks	4 Irving place
	William A. Armington	49 Wall street
	J. C. Bayles, M. E. Ph.D	41 Park Row
	William R. Beal	1 West 121st street
	Fritz Behrend	54 Front street
	S. Bernstein	82 West Broadway

New York.....C. W. Blodget .....43 West 37th street
A. E. Boardman..... 44 Broad street
Fred L. Bradley.. ....302 East 99th street
William H. Bradley.....4 Irving place
Ernest C. Brown ..... 280 Broadway
Howard Bruce ..... 4 Irving place
Lewis Sayre Burchard .....6 Wall street
Herman Burgi.....1173 East 139th street
E. P. Callender ..... 42 Pine street
William Carpender.....44 Pine street
Robert A. Carter ....4 Irving place
C. F. Chandler ..... 51 East 54th street
F. P. Cheesman ..... 92 William street
M. D. Compton .....16 and 18 Park place
Alfred S Cooke.....40 Wall street
Edward L. Cox ..... 371 Fifth avenue
William M. Crane.....1131 Broadway
Wm. L. Dickel .....136 Liberty street
J. Alfred Dixon.....160 Broadway
Robert M. Dixon.....160 Broadway
Henry L. Doherty.....40 Wall street
M. J. Drummond ..... 192 Broadway
George B. Edwards... 113 Chambers street
A. B. Eilbeck.....40 Wall street
Frederick W. Floyd ...742 East 12th street
Sheldon J. Glass.....40 Wall street
Malcolm Montrose Graham..340 Third ave.
William S. Gribbel.....52 Dey street
Arthur H. Hall..... 350 Alexander avenue
Douglass Hamilton...1815 Webster avenue
C. C. Hartpence..... 126 Liberty street
Sterling F. Hayward.....395 Broadway
Richard S. Hicks..... 73 Warren street
C. M. Higgins.....26 Broadway
David L. Hough.....13-21 Park Row
Wm. G. Hoyt.....801 Third avenue
Alexander C. Humphreys.31 Nassau street
C. J. R. Humphreys..... 31 Nassau street
Charles W. Isbell.....245 Broadway

New York.....C. N. Jelliffe.....40 Wall street
Edward R. Jourdan..... 4 Irving place
James S. Kennedy.115th st. and East River
Wilbur M. Lippincott.....55 Park place
Burdett Loomis.....52 William street
E. G. Love..... 122 Bowery
Robt. O. Luqueer..... 31 Nassau street
W. N. McIlravy.....17 Battery place
Emerson McMillin.....40 Wall street
Converse D. Marsh.....136 Liberty street
J. Alex. Mayers.....44 Broad street
William N. Milsted..11th ave. and 47th st.
Albion L. Page.....180 Fulton street
Geo. Q. Palmer.....742 East 12th street
Geo. W. Parker.....45 Broadway
James D. Perkins .. 228 Produce Exchange
Daniel J. Prendergast.....33 Nassau street
Geo. G. Ramsdell..... 395 Broadway
William W. Randolph..... 31 Nassau street
A. F. Reichelt.....43 Cedar street
Eugene H. Rosenquest..... Westchester
Thomas F. Rowland...329 Madison avenue
F. Schniewind..... 17 Battery place
G. Schumacher.....116 Nassau street
F. Seaverns.....228 Produce Exchange
L. W. Serrell..... 99 Cedar street
C. C. Simpson.....4 Irving place
Chas. F. Terhune.....1133 Broadway
Lucien P. F. Tull.....340 Third avenue
H. D. Walbridge.....7 Wall street
George H. Warner..... 1131 Broadway
Wesley Webber.....6 Wall street
Adam Weber.....Park Row Building
Oscar B. Weber.....Park Row Building
F. K. Wells.....356 Fourth avenue
William Henry White.....44 Broad street
Charles R. Whittier.....10 Bridge street
Edwin E. Witherby..... 40 Wall street
George E. Woods..... 4 Irving place

New York	A. L. Woollen	501 West 146th street
	Oscar F. Zollikoffer	49 West 54th street
Niagara Falls	Albert H. Merritt	615 Ferry avenue
Nyack	A. M. Voorhis	Broadway
Plattsburgh	George M. Cole.	
Port Chester	John T. Fiske.	
	Wm. A. Mills.	
	F. M. Roberts	Main and Adee streets
	H. G. Williams	101 N. Main street
Port Jervis	R. S. Weaver.	
Poughkeepsie	Thaddeus R. Beal.	
	James M. Hadden.	
Ravenswood, L. I. City, W. Cullen Morris.		
Rhinebeck	Eugene T. Lynch.	
Rochester	John F. Bush	1124 St. Paul street
	G. W. Graves	32 South avenue
Saratoga Springs	P. F. Roohan	491 Broadway
Stapleton	Thos. O. Horton	264 Bay street
	Wm. J. Welsh	264 Bay street
Syracuse	John J. Cummins.	
	T. Littlehales	715 E. Genesee street
	J. F. Wilcox.	
	Austin C. Wood	216 North West street
Tarrytown	H. L. Davis.	
	Augustus Konrad	40 N. Washington street
Tonawanda	L. T. Palmer.	
Watertown	Henry C. Whitney.	
	C. F. Coffin.	
White Plains	Paul Bucher	155 Railroad avenue
	George Davies	155 Railroad avenue
	F. K. Lane.	
Yonkers	R. M. Kellogg	119 Woodworth avenue
	Geo. T. Macbeth	119 Woodworth avenue
	A. C. Pease	119 Woodworth avenue
	F. C. Slade	76 Highland avenue
	B. W. Stilwell	240 Palisade avenue

NORTH CAROLINA.

Charlotte	M. Nisbet Latta.	

Wilmington.....John W. Reilly.....116 South Sixth street
Winston-Salem ..R. V. Howes.

OHIO.

Bucyrus .....J. W. Gwynn.
Canton.....L. W. Wells.....137 East 5th street
Cincinnati.....Andrew Hickenlooper....838 Dayton street
William A. Miller.cor. 4th and Plum streets
James E. Stacey.....239 Mill street
Cleveland .....Franklyn L. Alcott.
Malcolm S. Greenough..356 Superior street
Frank M. Gregg ..1800 E. Madison avenue
Howard E. Mann ..Foot of Willson avenue
Virgil G. Marani.....356 Superior street
Melvin Pattison.
P. Plantinga.....720 Citizens' Building
W. E. Steinwedell ...720 Citizens' Building
H. J. Trenkamp.
Daniel R. Warmington ....410 Pearl street
George H. Warmington....410 Pearl street
Dayton.....E. E. Brownell.
W. P. Callahan.....901 East Third street
Robert R. Dickey..Main and Second streets
Henry C. Graves..Main and Second streets
Geo. Light.....205 East First street
Joseph Light .....203 East First street
John K. McIntire....116 North Main street
Delaware.....T. C. Jones.....6 West Winter street
Hamilton.....Lazard Kahn.
Lorain.....Sterling H. Bunnell.
Marietta .....Beman G. Dawes.
Piqua .....Stanhope Boal.
Steubenville .....J. Chas. Ross.
Toledo .....C. A. Byers.
Chas. R. Faben, Jr...327 South Erie street
Fred. R. Persons.....430 Superior street
Warren.....George H. Tayler.....209 Main street
Zanesville .....Eugene Printz .....North Sixth street

OKLAHOMA TERRITORY.

Oklahoma	A. H. Branch	110 North Broadway

OREGON.

Portland	Charles F. Adams	Fifth and Yawhill sts.

PENNSYLVANIA.

Allegheny	John Young	603 West Diamond street
Allentown	Arthur F. Bigelow	540 Hamilton street
Altoona	George H. Harper	2526 Broad avenue
Ardmore	C. H. Quackenbush.	
	J. F. Butler.	
	I. N. Knapp.	
Bethlehem	Warren J. Flick	74 South Main street
Carlisle	John Hays.	
Chester	John M. Callanan	517 Market street
	Thos. G. Littlehales.	
	John D. Shattuck	517 Market street
Coatesville	David Buck, Jr	Taylor Hotel
Easton	B. F. Cresson.	
	Edwin G. Holzer	North Front street
Erie	Albert McDonald.	
	F. H. Payne.	
Harrisburg	L. S. Williams	27 North Third street
Hanover	R. Hayes Dutton	15 Baltimore street
Honesdale	Henry Z. Russell.	
Johnstown	Wm. H. C. Ramsey	420 Main street
Lancaster	J. H. Baumgardner	129 North Queen street
	C. Edgar Titzel.	
Lebanon	Wm. H. Merritt.	
Llanwellyn	E. W. Hammond.	
Lumberville	E. H. Tinsman.	
Middletown	E. A. Pinkney.	
New Brighton	R. L. Kenah, Jr	Penn avenue
Norristown	Herbert H. Ganser.	
Otto	J. F. Nicoll.	

Philadelphia ....Henry C. Adams....224 South Third street
W. A. Allison.....2142 Sedgley avenue
F. M. Arthur.....1615 North Ninth street
James Ball.
H. S. Battin.....Broad and Arch streets
A. B. Beadle.....528 Bourse Building
Samuel T. Bodine..Broad and Arch streets
William H. Bower,
Gray's Ferry Road and 29th street
Cyrus Borgner.....23d street, above Race
E. L. Brundrett.....1401 Arch street
James Buckman.....8th and Green streets
M. W. Butler.....2108 North 20th street
L. L. Cadwallader.....408 Lyceum avenue
Henry R. Cartwright,
N. W. cor. 22d and Arch streets
Wm. A. Castor...1646 Dyre st., Frankford
H. B. Christy...1308 Arrott st., Frankford
Walton Clark.....Broad and Arch streets
H. W. Coleman.....Land Title Building
D. J. Collins.....Broad and Arch streets
Roger B. Combs....Broad and Arch streets
J. A. P. Crisfield....Broad and Arch streets
Arthur R. Cruse,
1205 Stephen Girard Building
G. W. Curran.....Broad and Arch streets
Samuel Philip Curtis...222 S. Third street
Carl A. Dickel...961 North Marshall street
W. F. Douthirt.....Broad and Arch streets
H. T. Duke.....625 Drexel Building
Philip Dunne.....1931 South Ninth street
Edward H. Earnshaw..22d and Filbert sts.
George W. Elkins.....423 Walnut street
W. R. Elliott.....1401 Arch street
William P. Fodell.....50 Laurel street
Walton Forstall....Broad and Arch streets
John Fowler.....39 Laurel street
John A. Frick.
William H. Gartley.....1401 Arch street

Philadelphia.....Thomas S. Genay.. Broad and Arch streets
Thomas L. George..Broad and Arch streets
P. H. Gibbons .....2017 Morris street
W. W. Gibbs..... 850 Drexel Building
H. D. Gillingham,
4529 Pulaski avenue, Germantown
Harold W. Graeff ..... 1824 Tioga street
L. C. Graham..... 5715 Ashland avenue
Albert Green...4518 Tacony st., Frankford
John Gribbel.....1513 Race street
Charles F. Hardick .... 5961 Ridge avenue
J. A. Harris ..... 1513 Race street
William E. Helme.....1339 Cherry street
William H. Hopper,
137 West Washington lane, Germantown
A. Hurlburt.....Broad and Arch streets
D. E. Keppleman....3729 N. Carlisle street
John B. Klumpp....Broad and Arch streets
A. R. Laubenstein ...1946 North 23d street
Lewis Lillie.....Broad and Arch streets
Joseph Lucena.....3650 Market street
Alex. J. McCleary...22d and Filbert streets
Edmund H. McCullough...224 S. 3d street
John McIlhenny.....1339 Cherry street
John D. McIlhenny.....1339 Cherry street
Andrew P. Maloney..... 1504 Tioga street
Wm. D. Marks..... 216 The Bourse
W. H. Marshall..... 1401 Arch street
Sidney Mason.....U. G. I. Building
Martin Molony.... 37th and Market streets
Henry G. Morris..408 Philadelphia Bourse
Frederick N. Morton.. Broad and Arch sts.
Carroll B. Nichols.. 224 South Third street
Rollin Norris .....1401 Arch street
Carter H. Page, Jr., Broad and Arch streets
John C. Parker, 127 Seymour st., Germant'n
Joseph S. Parker....2003 S. Cleveland ave.
Joshua Ash Pearson, Broad and Arch streets
Joseph A. Perry.... Broad and Arch streets

Philadelphia.....Clarence V. Roberts, 257 North Front street
George J. Roberts.. Broad and Arch streets
E. H. Rodgers.....1434 Randolph street
William L. Rowland.. 4800 Chester avenue
John M. Rusby.....Broad and Arch streets
F. F. Schauer..... 2157 N. Van Pelt street
Charles L. Scott...Commonwealth Building
William J. Serrill ...Broad and Arch streets
F. H. Shelton....15th and Chestnut streets
John W. Smith.....60 Laurel street
William H. Smith ... 1931 South 9th street
B. H. Spangenberg,
19th st. and Allegheny avenue
Henry Steck..... 631 Chestnut street
J. W. Stirzel.....1517 Erie avenue
Morris W. Stroud...222 South Third street
Paul Thompson,...Broad and Arch streets
Wm. Nichols Tolman.. 22d and Filbert sts.
W. Graham Tyler.....3638 Chestnut street
E. S. Umstead.....1934 N. Gratz street
Gilbert I. Vincent ..4427 Frankford avenue
E. P. Walter,
6554 Germantown ave., Germantown
John S. Welch....cor. Broad and Arch sts.
Henry Wharton.....224 South Third street
John S. Wilbraham.2518 Frankford avenue
John W. Wilbraham.2518 Frankford avenue
T. G. Williams .....1931 S. Ninth street
Edward R. Wood, Jr...400 Chestnut street
Stuart Wood .....400 Chestnut street
T. B. Wood.....Broad and Arch streets

Pittsburg.....H. A. Carpenter.
Joseph F. Guffey .....435 Sixth avenue
W. B. Osborne.
Peter Young .....202 Lewis Building
Robert Young.....610 Wood street
Robert Young, Jr.

Pottsville.....F. B. Aldrich.....200 West Market street

Reading .....John H. Keppelman, 144 North Fourth street

Royersford	John H. Mansur	436 Walnut street
Scranton	Wm. M. Marple	423 Jefferson avenue
	W. E. Barrett.	
	Robert Reaves	3 Platt place
	Worthington Scranton.	
Steelton	Avery Clinton Sickels.	
Sunbury	George W. Beck	455 Market street
Williamsport	James W. Lane	1046 West Fourth street
Wyncote	Lewis R. Dutton.	
York	Grier Hersh.	
	Jacob L. Kuehn	33 East Philadelphia street
	Fred R. Smart, Jr	25 W. Market street

RHODE ISLAND.

Lakewood	Wm. H. Price.	
Newport	A. K. Quinn	181 Thames street
Pawtucket	Wm. McGregor	308 High street
	Geo. A. Stiness	123 Clay street
Providence	G. E. Allyn	15 Beacon avenue
	A. B. Slater	251 Rhodes street
	Edmund Cathels	34 Plain street
Riverside	James H. Armington.	
Woonsocket	John W. Ellis.	

SOUTH CAROLINA.

Charleston	Thomas Turner	224 Calhoun street
Columbia	John M. Daniels	1330 Main street

SOUTH DAKOTA.

Aberdeen	Charles A. Howard.	
Sioux Falls	W. H. McKenzie.	

TENNESSEE.

Bristol	Edwin M. Walker.	
Chattanooga	James Forbes	619 Cherry street
	Walter Forbes.	
	Robert Bruce Steward.	
Knoxville	Alfred W. Young.	

TEXAS.

Galveston .....John Gimper.

UTAH.

Salt Lake City ...John Kempf, Jr.....769 Main street

VERMONT.

Burlington .....Frank H. Parker...102 S. Winooski avenue
Robert B. Taber.
Rutland.....Roger W. Polk.....Berwick House
St. Albans.....C. W. Butterworth.....29 Kingman street

VIRGINIA.

Alexandria.....Harry M. Hantzmon...225 N. Royal street
Danville .....Frank Talbott.
Lynchburg .....Richard D. Apperson.....723 Main street
Newport News ..V. B. Barclay.
Norfolk ....Henry L. Rice.
F. H. Sawyer.....82 Plume street
Petersburg .....William H. Baxter ....201 Sycamore street
E. C. Pond.....135 Sycamore street
Portsmouth .....B. B. Ferguson.
Richmond .... ..W. P. Knowles .. .... 23 East Canal street

WASHINGTON.

Seattle.....C. Russell Collins ..... 1425 First avenue
Samuel Hill ....214 Cherry street
Spokane Falls ..W. A. Aldrich.....1517 First avenue
Tacoma ....Wm. W. Seymour.....1001 "A" street
Walla Walla ....C. E. Burrows .... 8 East Alder street
Whatcom .....W. S. Wharton .. ..301 Holly street

WISCONSIN.

Fond du Lac ....T. F. Grover.
Janesville .. .. ..Ira F. Wortendyke.
LaCrosse.....George MacMillan ....214 South 7th street
Manitowoc .....Julius Lindstedt .... 1111 South 8th street
Milwaukee .....Frederick A. Bredel .....405 Keene street
R. B. Brown .....182 Wisconsin street

Milwaukee .....Ewald Haase .....182 Wisconsin street
E. G. Pratt .....182 Wisconsin street
Portage .....W. A. Wilson.
Racine.....Henry H. Hyde .....305 6th avenue
Waukesha .....H. M. Buck.

AUSTRIA.

Vienna.....Carl Ritter Auer von Welsbach.
IV. Wiedner Hauptstrasse No. 69.

ENGLAND.

Liverpool .....William King .....Duke street
London .....Arthur G. Glasgow...38 Victoria st., S. W.
George T. Livesey.....Old Kent road
Horace G. Taylor, M. E.,
38 Victoria street, S. W.
John T. Westcott,
19 Abingdon street, Westminster, S. W.
Corbet Woodall,
Palace Chambers, Westminster.

FRANCE.

Lyon (Rhone) ..Th. Vautier .....46 rue Centrale
Paris .....Wm. C. Anderson, 23 Boulevard des Italiens

GERMANY.

Dessau.....W. von Oechelhaeuser.
Karlsruhe .....Dr. Hans Bunte.

JAPAN.

Tokio .....Suyekichi Hiramatsu.

NOVA SCOTIA.

Halifax .....Robert Baxter.
Fred. A. Huntress.
Sydney, Cape Breton..C. G. Atwater.

ONTARIO, CANADA.

Brantford .....Wm. M. Cathels .....48 George street
Chatham.....P. S. Coate.

Hamilton	Fred W. Gates	17 Herkimer street
	Robert A. Wallace	151 Park street, N.
London	Charles Forbes.	
	R. W. Kidner.	
Ottawa	John R. Coates	23 Sparks street
	Thomas Dunderdale	190 Ottawa street
St. Thomas	Geo. L. Oill.	
Toronto	Fred Burnett	269 Front street
	L. L. Merrifield	157 Dowling avenue
	William H. Pearson	19 Toronto street
	William H. Pearson, Jr.	95 Isabella street
Windsor	J. B. McNary.	
Woodstock	A. W. Moore.	
	H. H. Powell.	

QUEBEC, CANADA.

Montreal	W. R. Granger.	
	Samuel Skinner	177 Harbor street
Quebec	David H. Geggie	2 Place d'Orleans

ADDRESS UNKNOWN.

H. W. Benner.
W. S. Bowen.
Charles D. Hauk.
E. H. Henderson.
Frank B. Poor.
C. D. Strong.

SUMMARY OF GEOGRAPHICAL DISTRIBUTION.

Alabama	2	New York	179
Arkansas	1	North Carolina	3
California	13	Ohio	34
Colorado	6	Oklahoma Territory	1
Connecticut	23	Oregon	1
Delaware	3	Pennsylvania	151
District of Columbia	7	Rhode Island	9
Florida	9	South Carolina	2
Georgia	7	South Dakota	2
Territory of Hawaii	1	Tennessee	5
Illinois	36	Texas	1
Indiana	14	Utah	1
Iowa	9	Vermont	4
Kansas	2	Virginia	10
Kentucky	3	Washington	6
Louisiana	1	Wisconsin	11
Maine	5	Austria	1
Maryland	17	England	6
Massachusetts	57	France	2
Michigan	28	Germany	2
Minnesota	3	Japan	1
Missouri	24	Nova Scotia	3
Nebraska	3	Ontario, Canada	16
New Hampshire	6	Quebec, Canada	3
New Jersey	57	Address Unknown	6
		Total	797

MEMBERS DECEASED.

George W. Parsons	Rochester, N. Y.	——	—, 1875
Cornelius L. Everett	New York, N. Y	Oct.	—, 1877
G. T. Sutton	Peekskill, N. Y.	Apr.	—, 1876
Charles Collier	Selma, Ala	May	—, 1876
W. H. Perry	Bangor, Me	May	—, 1877
William B. Clelland	Vicksburg, Miss	Oct.	15, 1878
Gen. Laz Noble	Vincennes, Ind	Oct.	18, 1879
George Buist	Halifax, N. S	Nov.	2, 1879
Oliver G. Steele	Buffalo, N. Y	Dec.	10, 1879
George W. Edge	Jersey City, N. J	Jan.	1, 1880
Kerr Murray	Fort Wayne, Ind	May	6, 1880
John C. Buxton	Springfield, Ohio	July	20, 1880
George Dwight	Springfield, Mass	Feb.	1, 1881
Elmer W. Clark, Jr	Philadelphia, Pa	Mar.	5, 1881
Eli Butler	Meriden, Conn	May	24, 1881
Henry Budd	Philadelphia, Pa	May	28, 1881
Henry Cartwright	Philadelphia, Pa	June	30, 1881
Edwin Keith	Taunton, Mass	Apr.	30, 1882
G. Warren Dresser (Honorary)	New York, N. Y	May	27, 1883
M. H. Jones	Easton, Pa	June	1, 1883
W. H. Price	Cleveland, O	June	8, 1883
James D. Merriman	Vera Cruz, Mexico	June	10, 1883
A. W. Richardson	North Adams, Mass	Sept.	4, 1883
Miles W. Caughey	Erie, Pa	Sept.	20, 1883
Wilmer G. Cartwright	Hoboken, N. J	Feb.	23, 1884
Philips Peebles	Quebec, Can	May	15, 1884
Ignaz Herzog	New York, N. Y	Oct.	23, 1884
Thomas Butterworth	Rockford, Ill	Apr.	5, 1885
George Cornell	Youngstown, O	Apr.	22, 1885
Francis Thompson	Charlestown, Mass	Aug.	30, 1885
James D. Brewer	Springfield, Mass	Feb.	7, 1886
Emile J. Durand (Honorary)	Paris, France	Feb.	—, 1886
John Anderson	Ironton, O	June	25, 1886
James H. Walker, Sr.	Tonawanda, N. Y	Mar.	1, 1887
T. F. White	Houston, Texas	Feb.	28, 1888
John C. Pratt	Jamaica Plain, Mass	June	7, 1888
William Helme	Atlanta, Ga	June	12, 1888
Joseph H. Collins	Philadelphia, Pa	June	26, 1888
John M. Murphy	Baltimore, Md	Aug.	25, 1888
John McDougall	Hornellsville, N. Y	Nov.	2, 1888
C. H. Nash	St. Louis, Mo	Nov.	9, 1888
John Cartwright	Poughkeepsie, N. Y	Dec.	19, 1888
C. F. Maurice	Sing Sing, N. Y	Dec.	24, 1888

Robert B. Spice (Honorary).	London, England	May 11, 1889
Edward J. King	Jacksonville, Ill	Oct. 28, 1889
Oliver E. Cushing	Lowell, Mass	Jan. 17, 1890
THEOBALD FORSTALL	Chicago, Ill.	Jan. 19, 1890
William Parrish	Seneca Falls, N. Y	Jan. 19, 1890
Walter B. Houston	Rahway, N. J	Apr. 3, 1890
James Henri Rollins	Worcester, Mass	June 19, 1890
GEN. CHAS. ROOME (Honorary)	New York, N. Y	June 28, 1890
B. F. Sherman	New York, N. Y	Oct. 31, 1890
Nathaniel Tufts	Boston, Mass	Nov. 9, 1890
Geo. W. Kraft	Philadelphia, Pa.	Dec. 22, 1890
William Mooney	New York, N. Y	Jan. 21, 1891
William H. Down	New York, N. Y	Feb. 15, 1891
I. Linton	Ravenna, O	Mar. —, 1891
J. M. Sterling	Monroe, Mich	May 18, 1891
E. M. Russell	St. Louis, Mo.	May 28, 1891
Samuel Prichitt	Nashville, Tenn	Sept. 21, 1891
John Andrew	Chelsea, Mass	Feb. 10, 1892
Geo. Shepard Page	New York, N. Y.	Mar. 26, 1892
Charles Nettleton	New York, N. Y	May 5, 1892
Alfred M. Norton.	Nashua, N. H	July 13, 1892
George A. McIlhenny	Washington, D. C	Oct. 16, 1892
John J. Griffin	Philadelphia, Pa	Oct. 22, 1892
Austin M. Copp	Boston, Mass	Nov. 1, 1892
Fred. H. Odiorne	Boston, Mass	Jan. 3, 1893
Frank H. Dyer	Salt Lake City, Utah	Mar. —, 1893
Matthew Cartwright	Rochester, N. Y	Apr. 25, 1893
Henry C. Hordley	Cumberland, Md	May 5, 1893
Edward Jones	South Boston, Mass	Aug. 1, 1893
Thomas C. Hopper	Philadelphia, Pa	Feb. 23, 1894
Frederick A. Sabbaton	Troy, N. Y	Apr. 14, 1894
John H. Knowles	Richmond, Va	May 5, 1894
Paul S. Merrifield	New York, N. Y	May 12, 1894
Samuel G. Stiness	Pawtucket, R. I.	Nov. 5, 1894
Thomas D. Gilbert	Grand Rapids, Mich	Nov. 18, 1894
Geo. Henry Wells	Nashville, Tenn	Nov. 22, 1894
Thomas C. Cornell	Yonkers, N. Y	Dec. 29, 1894
Sylvester S. Townsend	New York, N. Y	Jan. 14, 1895
James McCutcheon	Pittsburg, Pa	Mar. 4, 1895
Oscar Zollikoffer	New York, N. Y	Apr. 7, 1895
A. P. Collins	New Britain, Conn	Apr. 21, 1895
Wm. C. Adams	Richmond, Va	May 19, 1895
C. A. Bennett, Jr	Freehold, N. J	July 24, 1895
Wilbur H. Townsend	New York, N. Y	Feb. 26, 1896
Jos. R. Thomas	New York, N. Y	Nov. 28, 1896
Jos. D. Weeks	Pittsburg, Pa	Dec. 26, 1896
John W. Newell	New Brunswick, N. J	Jan. 5, 1897
Fred. W. Norton	Nashua, N. H	Oct. 2, 1897

W. L. Proctor	Ogdensburg, N. Y	Nov. 17, 1897
James F. Rogers	Jamaica Plain, Mass	Dec. 18, 1897
George D. Cabot	Lawrence, Mass	Jan. 18, 1898
John Tracey	Poughkeepsie, N. Y	Mar. 19, 1898
Clefford L. Slade	Port Chester, N. Y	May 18, 1898
Wm. Gardner	Pittsburg, Pa	Aug. 5, 1898
Geo. S. Hookey	Augusta, Ga	Oct. 18, 1898
Wm. W. Greenough (Honorary)	Boston, Mass	June 17, 1899
Jerome Croul	Detroit, Mich	Sept. 26, 1899
Geo. W. Starr	Wallingford, Conn	Dec. 25, 1899
D. E. Knight	Marysville, Cal	Jan. 5, 1900
James Gardner, Jr	Pittsburg, Pa	Jan. 16, 1900
James M. Starr	Richmond, Ind	June 17, 1900
Milton J. Payne	Kansas City, Mo	June 17, 1900
Wm. J. Fay	Anaheim, Cal	Aug. 4, 1900
W. G. Chandler	Harrisburg, Pa	Aug. 14, 1900
George T. Thompson	Denver, Col	Oct. 1, 1900
W. G. Abel	Atlanta, Ga	Dec. 21, 1900
A. C. Gandey	Lambertville, N. J	Dec. 30, 1900
Harold Humphreys	New York, N. Y	Feb. 12, 1901
David W. Crafts	Northampton, Mass	Mar. 12, 1901
Charles C. Fry	Lynn, Mass	Mar. 21, 1901
William Stacey	Cincinnati, Ohio	June 17, 1901
James Slade	Yonkers, N. Y	June 18, 1901
Geo. B. Neal	Charlestown, Mass	July 7, 1901
Wm. E. Barrows	Philadelphia, Pa	July 30, 1901
Wm. W. Goodwin	Philadelphia, Pa	Oct. 6, 1901
Wm. Cartwright	Philadelphia, Pa	Mar. 8, 1902
Wm. L. Elkins, Jr	New York, N. Y	Mar. 14, 1902
Henry Morton (Honorary)	Hoboken, N. J	May 9, 1902
Elmer B. Knight	Far Rockaway, N. Y	June 17, 1902
E. H. Jenkins	San Antonio, Texas	June 23, 1902
Julius Buss	Milwaukee, Wis	Nov. 23, 1902
Frederick A. Welles	Jersey City, N. J	Dec. 16, 1902
William K. Park	Philadelphia, Pa	May 13, 1903
Eugene Vanderpool	Newark, N. J	July 12, 1903
Henry B. Leach	Taunton, Mass	July 25, 1903
Wm. A. Stedman	Brooklyn, N. Y	Nov. 8, 1903

Number deceased while on roll..... 129

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